

CFTRI-MYSORE



6320

Poultry keeping.

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POULTRY KEEPING IN INDIA



A Pair of Barred Plymouth Rocks

POULTRY KEEPING IN INDIA

BY

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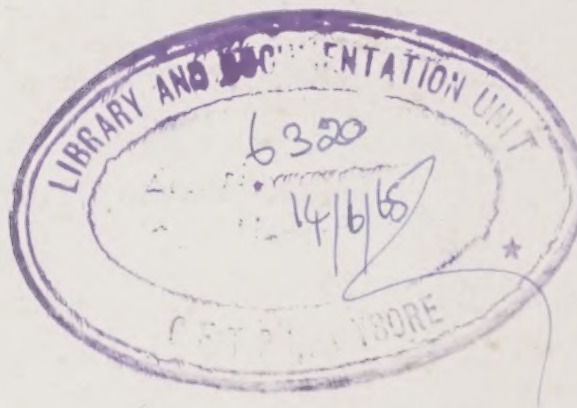
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Poultry keeping.

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PREFACE

POUULTRY keeping in India dates back to very early times. India is believed to be one of the earliest habitats of the wild jungle fowl from which all the modern breeds of poultry are said to have descended. It is, however, strange that in spite of a long tradition, poultry keeping has remained an under-developed industry in our country. The birds are still kept in small units under primitive conditions of housing, feeding and management. As little attention is given to scientific breeding, the birds are uneconomical both as meat and egg producers. The laying capacity of the Indian breeds is one-third of the world average. The eggs laid are also small in size and the meat poor in quality and flavour.

Poultry development on scientific lines is a recent enterprise in India. It started with the establishment of Poultry Research Section at the Indian Veterinary Research Institute, Izatnagar, about twenty-five years back. The Institute undertook fundamental research on important problems relating to poultry keeping and also initiated training schemes. A number of research and extension organizations were later set up in all the States. During the Second World War, the demand for eggs and meat increased considerably and provided a great impetus for the development of the industry. Several large farms with improved breeds were speedily established. These farms eventually contributed to the raising of nucleus stock of improved birds.

It was, however, only under our Five Year Plans that the development work was taken up in an intensive manner. Pilot investigations conducted by the Indian Council of Agricultural Research on large-scale rearing of chicks, intensive system of poultry farming and distribution of compounded poultry feeds gave encouraging results. These findings coupled with comprehensive poultry development plans taken up in the States created the necessary conditions for the development of poultry keeping in India. As a result of these efforts, poultry keeping today is a profitable occupation for many farmers in a number of States in the country.

The rapidly increasing demand for poultry products and the stimulus provided by the Government development plans have combined to attract in recent years more and more persons both in the villages and towns to poultry husbandry. This

PREFACE

growing interest has created the need for guidance and accurate information on all aspects of the enterprise.

To meet this growing need, the Indian Council of Agricultural Research published a book *Poultry Keeping in India* by Dr. P. M. N. Naidu in 1959. Since then, there has been a persistent demand from all those who are engaged in poultry farming in India either as a hobby or as a profession for a cheaper edition of this book. In view of this demand, the Council has brought out the present edition of *Poultry Keeping in India* at a sale price of Rs. 10.75 per copy. This price is practically half the price of the first edition. I hope that at this price the book will be well within the purchasing capacity of the students in agricultural and veterinary colleges, extension workers and others interested in poultry keeping.

Some of the material in this book is based on the unpublished notes of Shri S. G. Iyer, Head of the Poultry Division, Indian Veterinary Research Institute, Izatnagar, Dr. Tulsa Ram, Poultry Development Officer, Ministry of Food and Agriculture, Government of India and Shri Harbhajan Singh, Poultry Development Officer, Punjab. The production aspects of the book have been looked after by Shri D. Raghavan, former Chief Editor, Indian Council of Agricultural Research, with the assistance of Shri J. B. Bali, Sub-Editor. A few of the photographs have been obtained from outside sources; 'A Pair of Indian Red Jungle Fowls' from the Director, Zoological Survey of India and 'Aseel with Two Hens' from Shri S. A. P. Prasad, President, Andhra Poultry Association. Most of the remaining photographs were taken by Shri H. K. Gorkha, former Photographer of the Indian Council of Agricultural Research.

New Delhi
June 16, 1964

P. BHATTACHARYA
ANIMAL HUSBANDRY COMMISSIONER WITH
THE GOVERNMENT OF INDIA

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POULTRY IN INDIA

THE term poultry refers to domestic fowls which are reared for their flesh, eggs, or feathers, and includes barndoor fowls or 'chickens', ducks, geese, turkeys, guinea-fowls, pigeons, pea-fowls, etc. However, the most important member of the family is the barndoor fowl or chicken with which we are concerned in this book.

In the East, poultry keeping dates back to very early times. In fact, India and the neighbouring countries are considered to be the original home of the jungle fowl from which the domestic birds have descended. Similar references to poultry breeding in India are also found in ancient history. The Aseel, a noted Indian breed, was highly prized by lovers of cock-fighting all over the world. However, systematic rearing of birds for marketing was not common, and even to this day the poultry industry in the country continues to be a disorganised enterprise. The birds are raised mostly in the villages where they are maintained in small units without any care being taken about their feeding, housing, breeding, health or marketing. Degeneration of stock, slow rate of growth, low production, and heavy mortality are, therefore, the natural consequences.

The importance of poultry for raising the low nutritional standard of the country cannot be over-emphasized. Both the egg and the poultry meat are one of the richest sources of proteins. The egg is also rich in Vitamins A, D, B₁, B₂, and pantothenic acid, and the chicken meat contains a high quantity of thiamine, riboflavin and pantothenic acid. The high nutritional value of poultry products is evident from *Tables 1, 2 and 3.

Distribution of Poultry. The poultry population is fairly well distributed in the country except in the scarcely populated areas of the Punjab, Rajasthan, and the central and western States (Table 4). Apparently poultry does well in areas where cattle do not thrive, thus compensating for the comparatively poorer resources of animal protein there.

The poultry population in India consists mostly of the mongrel or non-descript varieties known collectively as the *desi* breeds. The total number of

* Report of F.A.O. Technical Committee on Poultry Production in Asia and the Far East, 1956.

POULTRY KEEPING IN INDIA

Table 1. AVERAGE COMPOSITION OF EDIBLE PORTION OF EGG, CHICKEN MEAT, RICE AND MILK

Components		Rice	Cow Milk Whole	Eggs		Chicken Meat
				Hen	Duck	
Water	per cent	13.0	87.3	74.0	71.0	66.0
Protein	„	7.1	3.5	12.4	13.0	20.2
Fat	„	1.1	3.5	11.7	14.5	12.2
Carbohydrate	„	78.0	5.0	0.9	0.5	..
Fibre	„	0.7	0.0	..	..	..
Ash	„	0.8	0.7	1.0	1.0	1.0
Calories	per 100 g.	359.0	65.0	163.0	189.0	200.0

improved birds of imported varieties constitutes only about 1.4 per cent of the entire poultry population. The imported breeds which have been bred and acclimatised to India are mostly the White Leghorn and the Rhode Island Red. Small numbers of Black Minorca, Plymouth Rock, Australorp, New Hampshire, Light Sussex, Brown Leghorn and other breeds have also been introduced on

Table 2. COMPOSITION OF PROTEIN IN RICE, MILK, EGG AND CHICKEN MEAT

Amino Acid		Rice	Cow Milk Whole	Hen Eggs	Chicken Meat
Arginine	Per cent	7.2	4.2	6.6	7.1
Histidine	„	1.7	2.6	2.4	2.3
Lysine	„	3.2	8.7	7.0	8.4
Tyrosine	„	5.7	6.0	4.5	4.3
Tryptophane	„	1.3	1.5	1.5	1.2
Phenylalanine	„	5.0	5.5	6.3	4.6
Cystine	„	1.3	1.0	2.4	1.3
Methionine	„	3(?)	3.2	4.0	3.2
Threonine	„	3.8	4.7	4.3	4.7
Serine	„	..	4.3	..	4.7
Leucine	„	8.2	11.3	9.2	..
Isoleucine	„	5.2	7.5	7.7	..
Valine	„	6.2	7.0	7.2	..

Table 3. AVERAGE VITAMIN CONTENT OF RICE, MILK, EGG AND CHICKEN MEAT

Vitamin	Rice Polished per 100 g.	Cow Milk Whole per 100 g.	Hen Eggs Liquid per 100 g.	Chicken Meat per 100 g.
Vitamin A (I.U.)	(0)	140	1300	..
Vitamin D (I.U.)	..	..	50	..
Vitamin B ₁ (mg.)	0.22	0.04	0.26	0.2
Vitamin B ₂ (mg.)	0.04	0.13	1.3	0.3
Pantothenic acid (mg.)	..	0.31	2.5	0.7

some of the farms. Of late, the breeding of the exhibition varieties has also received considerable impetus. However, the once famous Aseel is rapidly declining on account of the virtual disappearance of the cock-fighting sport.

Poultry keeping in India is largely in the hands of the poor peasants who usually keep about half a dozen laying birds, mostly of the *desi* breeds. These are maintained under primitive conditions of housing, feeding and management, and practically nothing is spent on them. The small income which the farmer's wife gets by selling the eggs and surplus chickens in the weekly market serves as a source of 'pin money' with which she buys her modest needs. Thus, in spite of the scant care and attention given to the *desi* hen and in spite of her low productivity, she is still a valuable member of the farmer's household.

The village hen, small and active, is an ideal sitter and mother. She does not normally suffer from some of the diseases (such as fowl leucosis) to which the improved breeds readily succumb. It would appear that her genetic make-up is well-adapted to a struggle for existence to which she is born. Under suitable environmental conditions and management, she can also give a good performance in regard to both the production and size of eggs, as shown by the experiments undertaken at the Indian Veterinary Research Institute. The meat is also delicious. In any plan of poultry development envisaging the upgrading of *desi* birds with imported breeds, care should, therefore, be taken to retain the favourable genes of the breed. For this a nucleus of indigenous breeds in a pure state and in adequate numbers will have to be maintained.

Economics of Poultry Production. The rapidly increasing demand for poultry products and the stimulus provided by the Government development plans have combined to attract in recent years more and more persons, both in the villages and towns, to poultry husbandry. This growing interest has created the need for accurate information on all aspects of the enterprise.

The main factors on which success of poultry farming depends are: business ability, marketing facilities, knowledge and experience, capital, breeds and equipment. A large percentage of failures can be traced to lack of business capacities and the necessary knowledge and experience. Similarly, inadequacy of

POULTRY KEEPING IN INDIA

Table 4. POULTRY POPULATION IN INDIA (1961)

Sl. No.	State	Poultry
1.	Andhra Pradesh ..	16,248,132
2.	Assam ..	11,251,211
3.	Bihar ..	12,357,834
4.	Gujarat ..	2,047,061
5.	Jammu & Kashmir ..	1,608,422
6.	Kerala ..	9,106,320
7.	Madhya Pradesh ..	6,525,289
8.	Madras ..	11,296,370
9.	Maharashtra ..	10,769,635
10.	Mysore ..	9,522,155
11.	Orissa ..	6,547,672
12.	Punjab ..	2,237,123
13.	Rajasthan ..	718,015
14.	Uttar Pradesh ..	3,254,310
15.	West Bengal ..	11,674,758
16.	Delhi ..	78,677
17.	Himachal Pradesh ..	90,690
18.	Manipur ..	785,509
19.	Tripura ..	703,172
20.	Andaman & Nicobar Islands	76,655
21.	Laccadive, Minicoy Amindivi Islands ..	15,119
	Total ..	116,914,129

capital, equipment and proper breeds constitutes a serious handicap for the poultry farmers. A minimum of capital and equipment is needed for making a proper start. It would be inadvisable to commence operations without appreciating that during the first two years, the enterprise would involve considerable expenditure without much return. A good deal of planning, forethought and tenacity of purpose is, therefore, needed to make a proper start. Side-by-side selection of the right type of breeds has to be given the highest importance.

In the villages situated in close proximity to cities and large towns, the production of eggs is more profitable than meat production, as the availability of

necessary, transport facilities make their marketing easy. Particular attention should, therefore, be given in these areas to the laying ability of hens. However, in the remotely placed villages, the emphasis should be on developing poultry for meat, for the eggs being a highly perishable commodity would present serious marketing problems. The birds can be transported from such areas with comparatively fewer risks, and the poultry farmer can bide his time to secure a good price for them. It is obvious, therefore, that a thorough understanding of the breeding methods is very essential.

In fact, without this knowledge no amount of good feeding and management will help the poultry keeper to make a success of his venture. This, however, does not imply that feeding and management are to be treated as of minor importance. It is only through good feeding that a well-bred flock can respond efficiently. Also, proper management, which includes methods of hatching, rearing, housing and sanitation, is of vital importance. Again, even if the poultry unit is broad-based on all the essential requisites, it may still prove unsuccessful if sound marketing arrangements are not devised. The marketing of meat and eggs can be carried out profitably only when there is a sufficient quantity to be sent out. For this purpose, some kind of co-operative or collective method has to be thought of by the poultry keepers of each particular area.

The success of a venture will depend on the extent to which all the essential factors, briefly mentioned above, can be combined to an optimum degree. Thus, for instance, if the feeding practices do not conform correctly to the requirements of a particular breed, there will be loss. Leghorn hens and those of similar breeds, laying an average of approximately 150 eggs per year, consume from 70 to 85 lb. of grain per year while Plymouth Rocks, Rhode Island Reds and Wyandottes laying an equal number of eggs consume 80 to 85 lb. of grain. No stiff formula can, therefore, be followed in regard to the quantity that should be fed to the birds. It has also to be remembered that in the production of eggs sufficient adjustment is needed for meeting the varying market demands in different months of the year. Thus, 10 eggs laid in December or January are worth about 15 or 20 produced in the summer months.

An effort has been made in the chapters that follow to provide scientific information on the more important aspects of poultry keeping. It may, however, be emphasised that nothing can replace practical experience, and that each poultry farmer must evolve his own particular system to suit his special circumstances. It is generally agreed that the best way to start a poultry enterprise is to make a beginning in a modest way. Expansion and development will follow in the natural course, and the business will build itself gradually.

BREEDS AND VARIETIES OF CHICKENS

A BREED in the context of poultry may be defined as a group of fowls, all members of which are descended from common ancestry, are similar in shape and conformation, and breed 'true to type'. Each breed has its distinctive characteristics, and is developed for some special purposes. Some birds, for example, are well known for their laying capacity; others for their hardiness or ability to keep well and strong even under difficult conditions; and still others for their size or quality of flesh. Such external features as the plumage colouring and colour of the legs, combs, wattles and ear-lobes are also considered while defining the breeds. Between sixty and seventy distinct breeds of fowls have been listed, but not more than twenty or twenty-five have noteworthy economic importance. Before proceeding to describe the various breeds, it will be useful to give a brief history of the origin of what is popularly called the domestic fowl or chicken.

From early times, the fowl has attracted great human interest. Primitive tribes in Africa, South America and the Pacific Islands have long been rearing chickens and it still remains a mystery how some tribes first obtained them. It seems that jungle fowls were domesticated in South-Eastern Asia before historical times. They were hunted for food, and the pugnacious character of the wild cock led to the development of cock-fighting and its pursuit as a sport. There can be no doubt that the sport of cock-fighting contributed largely to the domestication of the fowl and its subsequent distribution. The literature of several nations refers to this pastime; and it would appear that cock-fighting was as much responsible for the domestication of the fowl as the demand for it as food, and that the sport was chiefly instrumental in the widespread distribution that followed. In some countries, including parts of India, cock-fighting is still practised on the quiet.

Migration and Distribution. According to William Beebe, the reputed naturalist, the chicken appears in the hieroglyphs of the Orient as early as 3,200 B.C. The cock was known in India one thousand years before Christ. From India, the chicken moved northward and westward through centuries until it reached Greece in 525 B.C. Subsequent distribution of the fowl followed at the time of the Iranian invasion which carried the bird through Persia into Palestine.

Through the Jews of Palestine who were great traders, the fowl soon made its way to the British Isles, spreading thence to several parts of Europe as far down as Central Italy. By the beginning of the Christian Era it had spread over the western parts of Asia and eastern parts of Europe, from where it gradually made its way to other countries, including South Africa, Australia, Japan, Russia and America.

It seems certain that all the breeds of poultry known at present are descended from the wild jungle fowl inhabiting the vast stretch of area covering South and Central India, Assam, Burma, Ceylon and other South Asian countries. The jungle fowl can be seen today in the same forests they inhabited some thousands of years ago.

There are four known species of wild or jungle fowl, viz. *Gallus gallus*, commonly known as the red jungle fowl; *Gallus lafayetti*, the Ceylon jungle fowl; *Gallus sonnerati*, the grey jungle fowl; and *Gallus varius*, the Javan jungle fowl. It is generally believed that all domestic breeds of poultry have originated from the red jungle fowl (*Gallus gallus*) and that the other three species played no part in their origin. The red jungle fowl has five races or sub-species which are well marked, but not widely different, viz., *Gallus gallus bankiva* or Javan red jungle fowl; *Gallus gallus jabouillei* or Tonkinese red jungle fowl; *Gallus gallus murghi* or the Indian red jungle fowl; *Gallus gallus gallus* or the Cochín-Chinese red jungle fowl and *Gallus gallus spadaceus* or the Burmese red jungle fowl. The geographical distribution of these species in the wild state extends from north-western India through Assam, Burma, Thailand, Malaya, east to Indo-China, the extreme south of China, Hainan, Sumatra and Java.

Indian red jungle fowls (*Gallus gallus murghi*, Fig. 3) are generally confined to the northern and north-eastern parts of this country extending from the lower ranges of the Himalayas from southern Kashmir to Assam, northern and eastern Madhya Pradesh, Bengal, south to Godavari, Orissa, Ganjam, Visakhapatnam and parts of Godavari district.

The grey jungle fowl (*Gallus sonnerati*) is also found in India, confined mostly to western and southern India up to Mount Abu in the north-west and to the east of the Godavari river, Central India and Rajasthan. Hybrids with red jungle fowl are fertile but it is generally believed that *Gallus sonnerati* (grey jungle fowl) has no place in the ancestry of domestic breeds, even those which possess spangle-like spots resembling those seen on this wild species, as has been advanced by some authors.

PRINCIPAL GROUPS

Domestic fowls may be divided into two broad groups: the *desi* or the indigenous, and the exotic or the improved.

DESI BREEDS

The term *desi* is used to denote all indigenous fowls which, even if they have local names or pronounced characteristics, e.g., Tenis, Naked-neck, Chittagong,

Punjab Brown, Aseel, Ghagus, Lolab, Kashmir Faverolles, Titre, Busra, Karaknath, Denki (Fig. 6), Tellicherry (Fig. 7), Kalahasti, etc., are not of pure breeds on account of the promiscuous multiplication that has taken place over the centuries under uncontrolled village conditions.

The *desi* chickens exhibit great variation in their size and shape, and even in the smallest flocks various colours and conformations are generally observed. Nevertheless, they form the bulk of poultry population in India and are of little value as layers. The *desi* hen is, however, the best mother as a rule, and makes an ideal sitter. She is also very vigilant and a good forager. The *desi* breeds which are said to be more or less pure are the Aseel, Chittagong, and Ghagus.

Aseel. Aseel, which means 'real' or 'true', is the name given to an indigenous breed, because of its 'noble' qualities of 'fighting'. The original Aseel is a medium-sized bird commonly known as the Reza or the Tikra. The early recognition of its fighting qualities and power of endurance led to the development of the sport of cock-fighting.

Among the patrons of cock-fighting were the richer classes of people, including princes, who indulged in the sport for pleasure. To them goes much of the credit for improving the breed in size and weight. A good specimen of an Aseel cock measuring as much as 28 inches from beak to toe, and weighing over 9 lb. can be encountered. The remarkable endurance of an Aseel even during the most critical stages of the fight is proverbial, because it fights to the last and prefers going down fighting to withdrawing.

There is much controversy about the Aseel being described as the Indian Game. It is held by some that the Aseel is a pure 'game', while others think that it does not belong to the exclusive 'game' class. All the same it cannot be denied that with the waning of interest in the sport of cock-fighting, which is also banned in many parts of India, the Aseel as a breed has lost much of its importance, and pure specimens of it are getting more and more scarce. Inbreeding has greatly injured the breed both in size and conformation. The birds sold as Aseels in the various cities of the country are nothing but cross-breeds between the real Aseel and the indigenous fowls. This crossing is resorted to in order to lighten the weight of the cocks and to make them more agile. The Aseel, no doubt, imparts stamina to other breeds when crossed with them and also improves the flavour and quality of their meat, especially when crossed with exotic breeds.

The real Aseel is a large, noble-looking and dignified bird. Best specimens, though scarce, are still encountered with the fanciers in Andhra Pradesh (Fig. 5). It is not, however, an economical breed. The bird is a poor layer but is one of the best for table purposes having plenty of delicious flesh. The hen is a good sitter and an excellent mother, but is rather hard to keep because of its intensely pugnacious character. The young ones of the breed are somewhat delicate and need great care and freedom as they do not get on well in the company of other breeds.

The Aseel has a small strong beak attached to a somewhat broad skull. The comb is pea-shaped and small; the face is rather long and slender and not covered

with feathers; the eyes are compact, well-set and present bold looks; the wattles are rudimentary and almost imperceptible. The neck is long and uniformly thick, but not fleshy. The body is rather round and short, and presents a broad breast, straight back and a close-set strong tail root. The general feathering is close, scanty, and almost absent on the breast, thighs and the first joint of the wings. The plumage has practically no fluff and the feathers are tough and difficult to break. The tail is small and drooping to within a few inches of the ground. The legs are strong, straight, lean and set well apart. The bird presents an upright martial gait suggesting strength and alertness. The standard weight in pounds is: cock 9 to 10; hen 7 to 8.

Several varieties of the Aseel breed are known, the most famous being the 'Iran', named after the country of its origin from where it was brought to India by Iranian tribes, the Hyderabad Peela (Red), Nhurie (White), Yakhud (Black and Red), Dhummar (Glue-dust), Teekar (Brown), Zava (Laced), Patteda (Single comb) and Kavval (Bearded). Beside these, the Black, Duck-wing and Mottled varieties are also encountered.

Chittagong or Malay. The Chittagong breed is so named because it is largely bred in Chittagong. It is also known as the Malay as it was originally a native of Malayan Peninsula. 'Chittagong' is a large bird, the cock measuring sometimes 30 inches from beak to toe. Its weight in pounds, is: cock 8 to 10; hen 6 to 9.

The hen lays well, but is not a good mother. Young chickens are somewhat delicate during the first one or two months of their early life when they need good care. The adult birds are strong and very hardy. Because of their quarrelsome nature young chickens do well when they are reared separately and not mixed with those of other breeds. They do not like confinement. Given freedom, judicious feeding and damp-free surroundings, they thrive well. The Chittagongs grow fast and make ideal birds for the table. The flesh of the Chittagong fowl is excellent.

The Chittagong has a small pea-comb, which resembles a small lump of tiny warts. The head is long and the beak long and yellow. The wattles are red in colour and very small, almost hardly visible in the hen; the ear-lobes are small, usually red and at times admixed with little white; the eyes are white or light yellow; the eyebrows are prominent and overhanging, making the head look somewhat broad; the neck is long. The breast is broad, deep and fleshy; the shoulders are broad, the loins are slightly narrow; the back slopes gradually to the tail which is small and full and slightly drooping in the cock; the wings project at the shoulders and are carried high; the legs are yellow, free from feathers, straight, long and strong. The plumage is close to the body, firm, short and glossy. There is no standard plumage colouration, but the buff, white, black, dark brown and grey varieties are recognised, the buff, golden, and light yellow being most popular.

Ghagus. Ghagus is a peculiar Indian breed resembling the Faverolle in appearance but having feathers on the legs. It is hardy, resents confinement, and is a fair layer and good table bird. The hen is a good sitter and mother.

The comb is either single or pea-shaped and small in size; the wattles and ear-lobes are small; the neck is thick, and the throat loose and somewhat baggy. Some have whiskers and beards. The body is large and rather squarish; the legs are long, straight and strong, and yellow or greenish yellow in colour. The plumage colouration is red, bay, brown, black and grey. Ghagus is becoming scarce and appears to be dying out fast. The best specimens are sometimes seen with the nomads, especially in the Deccan.

IMPROVED OR EXOTIC BREEDS

The term 'Improved' is applied generally to the exotic and comparatively modern breeds of chickens (White Leghorn, Rhode Island Red, etc.), imported into this country, where they are bred and acclimatised to the local conditions. The introduction of exotic breeds of poultry in this country was done by the early European residents, such as the missionaries, planters and civil servants, who brought with them some of the good fowls developed in their native lands. The imported breeds have become quite popular. The number of pure-bred imported hens is, however, very small at present and constitutes barely 1.4 per cent of the total hen population in the country.

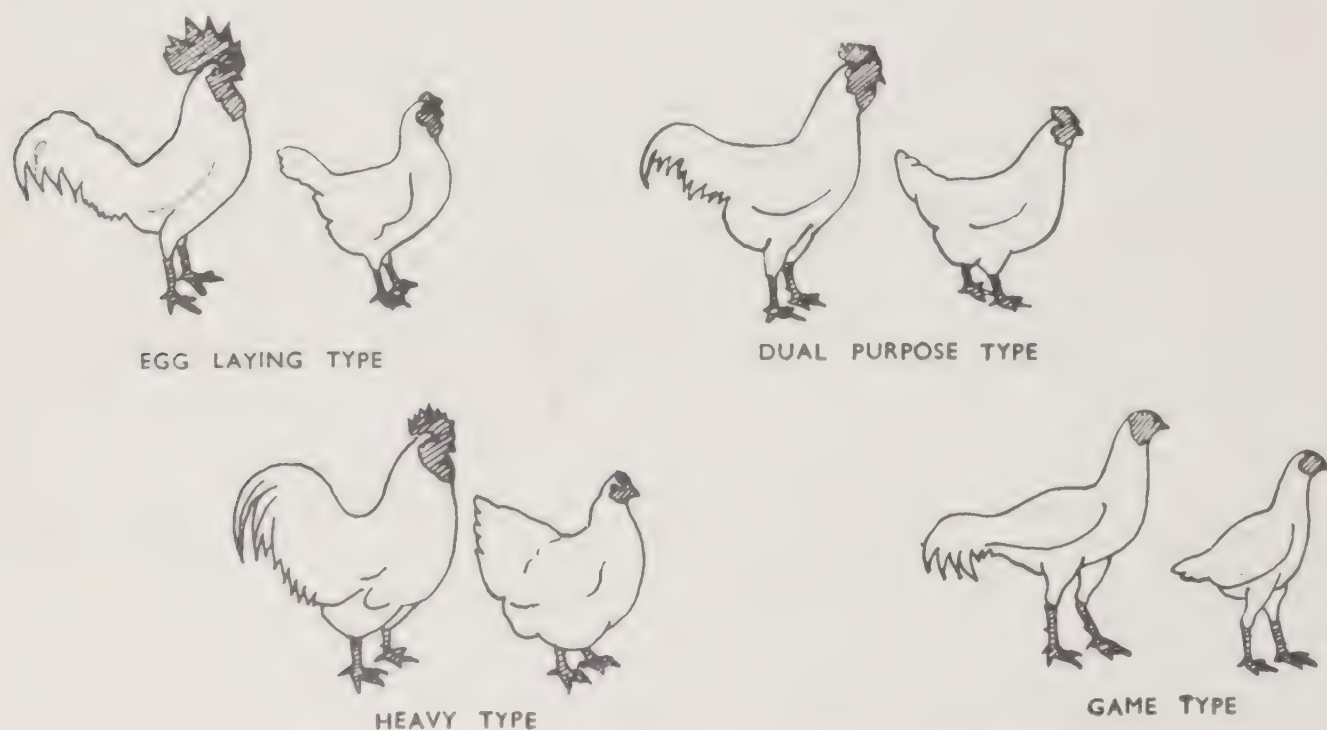


FIG. 1. BODY CONFORMATION OF DIFFERENT TYPES

Several of these relatively modern breeds are reared for both ornamental and commercial purposes. They are classified in different categories.

CLASSIFICATION OF CHICKENS

Chickens are divided into several classes and types; within each class are many breeds with various varieties; and each variety has different strains.

Type: It relates to a classification on the basis of the fowl's ability to produce a product of commercial value, which is virtually the purpose for which it is raised. Classification according to 'type' is based on factors such as eggs, flesh, and whether the fowl is dual purpose or miscellaneous. Type classification is also called Utility Classification.

Figure 1 illustrates the general body conformation of fowls grouped under different types, while Table 5 summarises the general characteristics of these types.

Table 5. GENERAL CHARACTERISTICS OF DIFFERENT TYPES OF POULTRY

Type	As Layer	As Broody Hen	As Table Bird	General Remarks
1. Egg laying	Very good	Poor	Poor	Light body, active
2. Dual purpose	Good	Good	Good	..
3. (a) Meat or Heavy	Poor	Good	Very good	Large body, plenty of flesh on breast
(b) Game	Poor	Good	Very good	Powerful build
4. Miscellaneous	Poor	Indifferent	Very poor	Delicate in build, bright plumage, small size, or possess unique features intended for pleasure or fancy
5. Local or <i>Desi</i>	Poor	Very good	Poor	..

Class: It refers to the official or 'standard' classification which distinguishes various groups of birds, largely on the basis of geographical regions where they were originally developed. For example, the American class is composed of breeds developed in the U.S.A. There are about 50 breeds of chickens grouped into 12 classes and sub-divided into several varieties.

The most important classes are: American, Asiatic, English and, Mediterranean.

Breed: As stated earlier, breed is a sub-division under either type or class. Examples of the breed are Rhode Islands and Leghorns.

Variety: By variety is meant a sub-division of a breed. It is characterised largely by a distinctive colour of the plumage and the special formation of the comb. As examples of variety there are white, brown, black and buff Leghorns and rose-comb and single-comb Rhode Island Reds. There are various types of combs which determine the variety. The single, pea, rose, strawberry and V-shaped combs of different varieties are shown in Fig. 2.

Strain: By strain is meant a group of birds within a variety. The strain is usually named after the breeder responsible for its development, e.g., the Babcock's strain of White Leghorns. Strain may be regarded more or less as a family of fowls which has been developed with some special characteristics in view, such as size, early maturity or production.

Male heads: 1. Single (Plymouth Rock); 2 and 3. Pea (Brahma); 4. Rose (Wyandotte); 5. Single (Minorca); 6. Single (Leghorn); 7. V-shaped (Houdan); 8. Rose (Hamburg); 9. Strawberry (Malay).



Female heads: 1. Single (Plymouth Rock and Rhode Island Red); 2. Pea (Brahma); 3. Rose (Wyandotte); 4. Single (Minorca); 5. Single (Leghorn); 6. Rose (Rhode Island Red).

FIG. 2. DIFFERENT TYPES OF COMBS OF MALE AND FEMALE BIRDS
(From 'Poultry Husbandry' by Morley A. Jull)

Egg Type. The fowls which constitute the egg-breeds belong to a widely distributed and popular group. The term 'egg-breed' is used because of the ability of some breeds to produce a good number of large-sized eggs. The choice of the breed of chickens for a commercial egg farm should, therefore, be confined to this type. They can be kept in large flocks and handled as a unit, thereby ensuring necessary care and management with a minimum amount of labour. Their bodies are comparatively small; hence they consume a relatively small amount of feed in proportion to the yield of eggs.

Among the breeds classed as egg type are the Leghorns, Minorcas, Anconas, Campines, etc., of which the first is the most popular.

Meat Type. The meat type includes breeds and varieties characterised by large frames or skeletons. Their ability to put on flesh is their chief commercial

advantage. The birds of this group are generally large in size and heavy in weight. They are loosely feathered, which gives them a full rounded appearance. The meat is tender owing probably to their slow growth and disposition. When young, birds are ugly and ungainly, because of their long and large bones, but at maturity they become fleshy and plump, most of the flesh being on the breast, thighs and back.

The meat breeds include the Brahma, Cochins, Langshan, Cornish, Game, Jersey Giants, Ascel and Chittagongs.

Dual or General-purpose Type. The dual type includes breeds which are distinguished by their ability to yield meat of excellent quality alongside a good number of eggs. They are ideal birds for a small flock maintained especially in urban areas and under backyard farming conditions. As a rule, they lay a reasonably large number of good-sized eggs during their pullet and yearling period, after which they may be consumed or marketed. They are nice and plump when 12 to 15 weeks old, and do not possess the large frames or skeletons of the meat breeds. If properly managed they lay eggs in all seasons, including the fall and winter, when the egg-laying breeds generally go in moult. They have a tendency, however, to become so fleshy and fat as to cause egg production to fall unless carefully fed and managed.

The common dual-purpose breeds are the Rhode Island Red, Plymouth Rock, New Hampshire, Wyandotte, Australorp, Orpington and the Dorking.

Miscellaneous Type. The miscellaneous type includes such breeds as cannot be placed among the egg, meat or dual-purpose breeds. They are not of much economic importance. Nevertheless, they are liked by some poultry keepers for some special features, such as beautiful plumage pattern which makes them valuable for exhibition or for keeping as pets.

Fancy Breeds. Certain breeds like the Polish, Hamburg and Andalusian create interest because of their beautiful plumage and other fancy points. They are ornamental and find a place in some exhibitions, although the utility breeds generally occupy a leading place in poultry exhibitions.

Birds Kept for Pleasure. Certain breeds like the Bantam are kept solely for the pleasure derived from breeding them. In colour and body type these birds are miniature replicas of large breeds and make excellent pets for children. Bantams are divided into two groups, the game and the ornamental. The game Bantams are sub-divided into a number of varieties similar in shape and colour to the standard Game fowls. Small game Bantams weigh only a few ounces, yet they possess the style, symmetry and alertness of the large Game. The ornamental Bantam group is of much interest to young people. The Asiatic Bantams, viz., the Brahma and Buff Cochin are the most popular breeds of this group. The Bantam Cochins have the typical body-shape and colour of the large Buff Cochin, but weigh only about fourteen ounces as against 8 or 9 pounds of the large Cochin. The Rose-comb Bantams are another group bred for pleasure and attract great interest at the exhibitions.

Some breeds possess certain distinctive features or marks which attract the

attention of the poultry keepers. For instance, the Spanish fowl is unique in having a white face which arouses great interest. The Polish and Houdan have a prominent crest which distinguishes them from the other varieties. The Silkie appears very unique in a poultry-yard because of its characteristic feathers, which resemble tufts of hair or thread. The plumage of this breed is white or grey: the skin and face are purplish. It is also called the *woolly* or *downy* fowl. Frizzle is the name given to another curious breed of chickens, because of the curly plumage. The quills of the feathers, instead of lying flat on the body as in other breeds, curve upwards and point towards the bird's head. This makes the feathers look as if they had been artificially curled. White is the popular colour of the Frizzle.

CLASSES AND BREEDS

According to the 'standard classification' chickens are divided into eleven classes. These are sub-divided into about 50 breeds (Table 6). Each breed has several varieties which differ from one another in plumage, colour and combs. There are approximately 150 varieties.

Table 6. STANDARD CLASSES, BREEDS AND VARIETIES OF CHICKENS

Class	Breeds	Varieties
1. American	Rhode Island Red	Single-comb, Rose-comb
	Rhode Island White	—
	Plymouth Rock	Barred, White, Buff, Silver-pencilled, Partridge, Columbian, Blue
	New Hampshire	—
	Wyandotte	Silver-laced, Golden-laced, White, Buff, Black, Partridge, Silver-pencilled, Columbian
	Jersey Black Giant	—
	Dominique	—
	Java	Black, Mottled
	Chanticleer	White, Partridge
	Lamona	—
2. Asiatic	Brahma	Light, Dark, Buff
	Cochin	Buff, Partridge, White, Black
	Langshan	Black, White
3. English	Sussex	Speckled, Red, Light
	Australorp	—
	Orpington	Buff, Black, White, Blue
	Dorking	White, Silver-grey, Coloured
	Cornish	Dark, White, White-laced Red, Buff
	Redcap	—
		Single-comb:
		Dark Brown, Light Brown

BREEDS AND VARIETIES OF CHICKENS

Table 6—Concluded

Class	Breeds	Varieties
4. Mediterranean	Leghorn	White, Buff, Black, Silver, Red, Black-tailed Red Columbian Rose-comb: Brown, White Single-comb: Black, White, Buff Rose-comb: Black, White Single-comb, Rose-Comb
	Minorca	White-crested Black
	Ancona Spanish Andalusian Buttercup	
5. Polish	Polish	Bearded: Golden, Silver, White and Buff laced; Non-bearded: Golden, Silver, White and Buff laced
6. Hamburg	Hamburg	Golden-spangled, Silver-spangled, Golden-pencilled, Silver-pencilled, White, Black
7. French	Houdan Crevecoeur La Fleche Faverolle	Mottled, White
8. Continental	Capine Lakenvelder	Silver, Golden
9. Game	Game	Black-breasted Red, Brown-red, Golden Duck- wing, Silver Duckwing, Birchen, Red Pyle, White, Black
10. Oriental	Sumatra Malaya Cubalaya	Black Black-breasted Red Black-breasted Red, White, Black
11. Miscellaneous	Sultan Frizzle	— —

The principal classes are the American, Asiatic, English and Mediterranean. Excepting the Asiatic, the other classes are of great commercial value. The distinguishing features of some representative breeds of chickens in these classes are given in Table 7.

Table 7. IMPORTANT CHARACTERISTICS OF SOME REPRESENTATIVE BREEDS OF CHICKENS

Breed	Standard Weight (in Pounds)				Type of Comb	Colour of Ear-lobe	Colour of Skin	Colour of Shank	Shanks Feathered	Colour of Egg
	Cock	Cockerel	Hen	Pullet						
American Breeds										
Plymouth Rock	9½	8	7½	6	Single	Red	Yellow	Yellow	No	Brown
Wyandotte	8½	7½	6½	5½	Rose	Red	Yellow	Yellow	No	Brown
Rhode Island Red	8½	7½	6½	5½	Single & Rose	Red	Yellow	Yellow	No	Brown
Rhode Island White	8½	7½	6½	5½	Rose	Red	Yellow	Yellow	No	Brown
Jersey Black Game	13	11	10	8	Single	Red	Yellow	Black	No	Brown
New Hampshire	8½	7½	6½	5½	Single	Red	Yellow	Yellow	No	Brown
Asiatic Breeds										
Brahma (Light)	12	10	9½	8	Pea	Red	Yellow	Yellow	Yes	Brown
Cochin	11	9	8½	7	Single	Red	Yellow	Yellow	Yes	Brown
Langshan (Black)	9½	8	7½	6½	Single	Red	White	Bluish-black	Yes	Brown
English Breeds										
Australorp	8½	7½	6½	5½	Single	Red	White	Dark-Slate	No	Brown
Cornish (Dark)	10½	8½	8	6½	Pea	Red	Yellow	Yellow	No	Brown
Dorking (Silver-grey)	9	8	7	6	Single	Red	White	White	No	White
Orpington (Buff & White)	10	8½	8	7	Single	Red	White	White	No	Brown
Sussex Light	9	7½	7	6	Single	Red	White	White	No	Brown
Mediterranean Breeds										
Leghorn	6	5	4½	4	Single & Rose	White	Yellow	Yellow	No	White
Minorca	9	7½	7½	6½	do	White	White	Dark-slate	No	White
Aneóna	6	5	4½	4	Single	White	Yellow	Yellow	No	White
Andalusian (Blue)	7	6	5½	4½	Single	White	White	Slaty blue	No	White

AMERICAN CLASS

There are eleven breeds in this class, of which the most popular are the Plymouth Rock, Wyandotte, Rhode Island Red and New Hampshire. All these breeds are said to have been developed in the United States, as a result of crossing the small active fowl brought from the Mediterranean area with the large sluggish fowl imported from Asia.

The breeds of the American class have the following common characteristics. In size they are midway between the Mediterranean and the Asiatic breeds. They mature earlier than the heavier birds from the East, but not so rapidly as the lighter breeds of the Mediterranean. They are good foragers and good sitters, and fatten readily. They are 'clean legged', i.e., their shanks are free from feathers. They have yellow legs and skin, except in the case of Java and Jersey Black Giants which have yellow skin but black shanks. All have red ear-lobes. They lay brown-shelled eggs and are classed as broody.

All American breeds can be classed as general or dual-purpose breeds, and are valuable for both eggs and meat. As broilers, the cockerels fetch a better price than those of egg or meat groups. They make excellent capons. Because of these attributes the American breeds are generally more popular than the others, and they suit the needs of the average farmer or poultry keeper very well.

Plymouth Rock. The Plymouth Rock is one of the most popular breeds in the U.S.A. mainly because it is a bird of good size with excellent flesh and good egg-laying capacity. The birds are somewhat long-bodied, rather broad with fairly prominent breast and good depth of body. The breed has a single comb. The standard weight, in pounds, is: cock $9\frac{1}{2}$; hen $7\frac{1}{2}$; cockerel 8; pullet 6.

The plumage colour of the Barred Plymouth Rock is greyish white, each feather crossed by almost black bars which are even in width, straight, extending down to the skin. The barring in the hackle and saddle of the male is narrower than in other parts. Solid black or partly black feathers may occur in some birds of practically all strains of this variety, but their appearance does not necessarily mean lack of purity. Black spots on the shanks are also common, particularly in females, but they do not indicate impurity of breed.

In progressive breeding of these birds, the males tend to become lighter in colour than the females. In the males, the black and white bars should be of equal width, whereas in the females the black bars may be one and a half times as wide as the white ones. Breeding from birds which have very narrow barring results frequently in slow growth, poor feathering in early life and defects in the wings and tails of adult birds. Mating of males and females with fairly good width of barring promotes the quality of the birds. Barred Plymouth Rock cocks, like those of the Rhode Island Red, are good for upgrading the ordinary village or *desi* birds.

Other varieties of the Plymouth Rock breed are the White, Buff, Silver-pencilled, Partridge, Columbian and Blue. In recent years the White variety is gaining in popularity, especially in the U.S.A., and good strains for egg and

broiler production have been developed. The breed has also been introduced in India lately, and appears to be very promising.

Wyandotte. The Wyandotte is essentially a breed of graceful curves, and has a comparatively rounded body set close to the ground. It is somewhat loosely feathered and has a short back, a rose-comb and a yellow skin. Like the Plymouth Rock, it is a good general-purpose breed, well adapted for flesh production and, when bred for egg production, can lay well. The standard weight, in pounds, is: cock $8\frac{1}{2}$; hen $6\frac{1}{2}$; cockerel $7\frac{1}{2}$; pullet $5\frac{1}{2}$.

The Wyandotte has the following varieties; White, Buff, Silver-laced, Golden-laced, Partridge, Silver-pencilled, Columbian and Black.

Rhode Island Red. The Rhode Island Red bird has a somewhat long, rectangular body, which is also broad and deep. The back is flat and the breast is carried well forward—characteristics which make it a good meat-producing bird. Through proper breeding the birds of this breed have also been developed into excellent layers of large brown-shelled eggs. It is in fact one of the best all-round breeds. Among the exotic breeds introduced in this country, it is by far the most popular.

The plumage of the Rhode Island Red is rich dark or brownish red in colour, evenly distributed over the entire surface, and is well glossed. The wing when spread shows black both in primaries and secondaries. The tail coverts, sickle feathers, and main tail feathers are also black. In the lower neck feathers of the female, there is also a slight black marking at the base. The usual colour of the breed is, no doubt, brownish red, but buff, white and brown are also met with. The brighter red has tended to be replaced by almost chocolate colour, with the result that it has become impossible to find too dark a red shade now. Tendency to smuttiness of the plumage colour is a common feature of this breed. Although such birds are no good for show purposes, they are very good for breeding.

There are two varieties of the Rhode Island Reds; the single-comb and the rose-comb, which are otherwise identical. The single-comb variety is the more popular of the two. The lobes are red and so are the eyes. Legs and feet are generally deep yellow or reddish horn and the beak reddish horn.

The Rhode Island Red is admittedly one of the hardiest of all breeds. The chickens grow quickly, are easy to rear, and no weather seems too severe for them. They stand cold and dampness very well and are, therefore, well suited for the wet and heavy rainfall regions. The standard weight in pounds is: cock $8\frac{1}{2}$; hen $6\frac{1}{2}$; cockerel $7\frac{1}{2}$; pullet $5\frac{1}{2}$.

Another variety, known as the Rhode Island White, is also found, but it is not popular.

New Hampshire. The New Hampshire is a relatively recent breed of the American Class developed from the Rhode Island Red stock. The shape of the body of the bird is less rectangular than that of the Rhode Island Red. Because of its unusual hardiness, it has gained great popularity within the past few years. The colour of plumage is chestnut red, but is not so well established as in the Rhode Island Red. It has a single comb. The breed is a good producer of large brown-

BREEDS AND VARIETIES OF CHICKENS

shelled eggs. The standard weight in pounds is: cock $8\frac{1}{2}$; hen 6; cockerel $7\frac{1}{2}$; pullet $5\frac{1}{2}$.

ASIATIC CLASS

The important members of this class are the Brahma, Cochin and Langshan. Besides being of special value for their meat, these breeds together with those of the Mediterranean class have formed the nucleus for the development of new breeds and varieties.

Fowls of this class mature slowly, are poor foragers and are persistent sitters. They are generally clumsy and sluggish in action and phlegmatic in disposition. They have feathered shanks (legs) and their eggs are brown-shelled.

Brahma. The earliest Brahma is said to have come from India in the Brahmaputra area, where the fowls of the original type, commonly known as 'Grey Chittagongs,' are still to be found. The Brahma fowl is massive in appearance and is easily one of the largest domesticated chickens. The breed may be light, dark or buff in plumage colour. It has a broad deep body which is loosely but well feathered. This gives the bird a blocky appearance. A pea comb and feathers on the shanks and toes are characteristic features. The standard weight in pounds of the light Brahma is: cock 12; hen $9\frac{1}{2}$; cockerel 10; pullet 8; and of the dark Brahma: cock 11; hen $8\frac{1}{2}$; cockerel 9; pullet 7.

Cochin. The Cochin hails originally from the Shanghai district in China and was known as the 'Shanghai fowl'. Its outstanding characteristics are a massive appearance and well feathered shanks. The breast is carried low, and in the female there is a prominent cushion at the base of the tail. The feathering is long and profuse, which makes the bird appear larger than it really is. The breed may be buff, white, black or partridge. The birds have single comb. The standard weight in pounds is: cock 11; hen $8\frac{1}{2}$; cockerel 9 and pullet 7.

Langshan. The Langshan has its origin in the Langshan district of China. As compared with Brahma and Cochin, the Langshan has a shorter but deeper body, longer legs and longer feathers on the tail. It stands up well, is well proportioned, and presents a graceful appearance. It has a single comb. The standard weight in pounds is: cock $8\frac{1}{2}$; hen $7\frac{1}{2}$; cockerel 8 and pullet $6\frac{1}{2}$.

ENGLISH CLASS

Six breeds comprise this class, but the more popular are the Sussex, Orpington, Australorp and Cornish.

The English breeds are mostly of the utility type noted for their excellent fleshing properties. Excepting the Cornish, all the breeds have white skin and red ear-lobes, and except the Dorking and Red Cap, all of them lay brown-shelled eggs. All are broody.

Sussex. The Sussex has a long body, broad at the shoulders and with good depth from front to rear. The breast is prominent and well developed and the bird has excellent fleshing qualities. Fowls of this breed have single comb and

horn-coloured beaks, shanks and toes. There are three varieties among the Sussex, the Light Sussex, the Red Sussex and the Speckled Sussex.

The Light Sussex (Fig. 4) is the most popular among them, and although originally a meat breed, good laying strains have since been developed, which make it a good all-round utility bird. The standard weight, in pounds, is: cock 9; hen 7; cockerel $7\frac{1}{2}$; pullet 6.

Orpington. The Orpington has a distinctive size and shape of body, which is long, deep and well rounded, with a full breast and a broad back. It is rather low set and heavy in bone, and is a little more loosely feathered than breeds of the American class. It is generally a good table bird, but good egg laying strains have also been developed by selective breeding and management. The comb is single. The birds may be buff, black, white or blue. Of these, the buff variety is the most popular. The black is of interest as it has led to the development of an increasingly popular breed—the Australorp of this class. The standard weight in pounds is: cock 10; hen 8; cockerel $8\frac{1}{2}$; pullet 7.

Australorp. As the name suggests, the Australorp was developed in Australia from the Black Orpington. It is more upright and less massive in appearance than the Black Orpington and has been developed as an egg producer. It has also a considerable amount of meat on its body which makes it a good dual-purpose breed. The back is somewhat long, and the body slopes gradually towards the tail. The body is of good depth; the feathering clings more closely to it than in the Orpington. The comb is single, the beak is black, and the shanks and toes are black or leaden black with pinkish white soles. The plumage colour is lustrous greenish black in all the sections, the under colouring is dull black.

The Australorp is rapidly gaining popularity in India, and like the Rhode Island Red is well suited for small-sized flocks in the 'backyard' type of poultry keeping, especially in the wet and heavy rainfall regions. In recent years the 'Austro White' which is a hybrid cross between the Australorp male and the White Leghorn female, has been found to be an excellent layer with good vigour and is maintained in large flocks in commercial egg farms. The standard weight of the breed in pounds is: cock $8\frac{1}{2}$; hen $6\frac{1}{2}$; cockerel $7\frac{1}{2}$; pullet $5\frac{1}{2}$.

Cornish. The Cornish, originally known as the Cornish Indian Game, is said to have been developed in England from crossing involving the Indian Aseel and the Malay and English Game breeds. Unlike the usual English breeds, which have white skin, the Cornish has yellow skin. For this reason, and also on account of its excellent fleshing qualities, the breed has gained popularity in some of the Western countries.

The Cornish is reputed for its close feathering and compact, well-fleshed body which has a distinctive shape. The breast is very deep and broad, giving the shoulders great width. All Cornish birds have pea comb. The standard weight in pounds of the dark and white varieties is: cock 10; hen $7\frac{1}{2}$; cockerel 8; pullet 6; and those of the white-laced red variety is: cock 8; hen 6; cockerel 7; pullet 5.

Dorking. The Dorkings, like the Sussex, are characterised by long, broad, deep and low-set bodies. The White Dorking has a rose-comb, while the other

two varieties have single combs. All Dorkings have five toes. The standard weight in pounds of the White Dorking is: cock $7\frac{1}{2}$; hen 6; cockerel $6\frac{1}{2}$; pullet 5; and of the Silver-Grey and coloured varieties: cock 9; hen 7; cockerel 8; pullet 6.

Red Cap. The name 'Red Cap' is derived from the large rose-comb which is the characteristic of this breed. It is a medium-sized bird possessing a fairly long body and a rather prominent breast. The standard weight in pounds is: cock $7\frac{1}{2}$; hen 6; cockerel $6\frac{1}{2}$; pullet 5.

MEDITERRANEAN CLASS

There are six breeds classified as Mediterranean because of their origin from the Mediterranean region. These are Leghorn, Minorca, Ancona, Spanish, Andalusian and Buttercup. Of all the breeds in this class, the Leghorn is by far the most popular. All the Mediterranean breeds have non-feathered shanks, and white or creamy white ear-lobes. With the exception of Minorcas, the fowls of this class are small in size. They mature early, are good foragers, possess a nervous, active temperament, and are non-sitters. They require less feed for maintenance and production than breeds of the other three classes. They are very good layers, their eggs being white-shelled.

Leghorn. The breed is small, active, and reputed for the harmony of its various parts. In appearance the Leghorn is the neatest of all birds. It is small and very compact in form, carries the tail rather low, and has a small head with well set comb and wattles. It has a relatively long back, prominent breast, and comparatively long shanks. Common varieties of the Leghorns are the White, Brown, Black and Buff. There are also other less common varieties such as the Silver, Red, Black-tailed Red and the Columbian. In the last few years the White variety has gained in popularity all over the world. Next in the order of popularity are the Brown and the Black.

The White, Buff and Brown varieties are sub-divided further on the basis of the character of the comb, i.e., whether it is rose or single comb. All the varieties have yellow beaks, skin, shanks (legs) and toes. They are identical in size and shape, and differ only in plumage pattern and type of comb. The standard weight in pounds is: cock 6; hen $4\frac{1}{2}$; cockerel 5 and pullet 4.

The single comb in the male is of medium size and stands erect, with five regular, deeply serrated points, the back of the comb extending straight from the back of the head. In the female, the front of the first point is erect but the rest of the comb droops to one side. The comb in both sexes is devoid of wrinkles, 'thumb marks,' or folds.

In the rose-comb variety, the comb of the male is of medium size and square in front, well filled and free from depressions or hollows; the spike is well developed and extends straight from the head. In the female the comb is small and neat and resembles that of the male.

The Leghorn produces good marketable eggs and is, therefore, ideally suited for commercial egg farms.

The White Leghorn is by far the most favourite variety on account of its excellent laying quality. The breed is not ideal for meat purposes, for which the Sussex, the Rhode Island Red and the Aseel are so well known. Nevertheless, in view of its quick growth especially during the early stages, it is largely used in the United Kingdom for the production of table birds under the name of *petit poussins*. Chicks of 6 to 8 weeks old when fed properly weigh from 12 to 24 ounces each, and their meat is tender and delicious to eat.

In the U.S.A., the breed is widely used in the broiler trade when the birds weigh from 1 to 2 lb. each. The carcass weight does not improve satisfactorily with the advancing age of the bird, the growth rate being retarded after 24 weeks. The White Leghorn matures within 5½ to 6 months, when the pullets start laying.

In India the White Leghorn has given good results especially in drier regions, while it does not seem to thrive and produce well on heavy soils and in wet areas. The breed was introduced in this country by foreign missionaries and European planters, less than half a century back.

Next to the White Leghorn, the Brown variety of the breed is gaining in popularity on the Continent where it has given good results. This variety has also been introduced in this country very recently and is full of promise. There are light and dark brown Leghorns, and in both of them the males are darker in colour than the females. The Brown Leghorns are, however, more popular because of the attractive plumage colour, especially in the male, which resembles that of the red jungle fowl. The plumage of the Brown Leghorn is, in fact, very much like that of the common *desi* bird. The breed is, therefore, well suited for introduction particularly in those areas where there is some prejudice against white coloured fowls. The breed seems to be hardier than the White Leghorn, and its colour, especially in the chicks, serves as a natural camouflage against predators. It deserves to be tried extensively in the country.

The Black Leghorn has been gaining in popularity in the United Kingdom in recent years. It has also been imported into India in small numbers. It is not as good a layer as the White and Brown varieties, and is usually mistaken for Black Minorca. But the typical head and body conformation of the Leghorn and the yellow beak, skin, shanks and toes distinguish the Black Leghorn from the Minorca. This variety has no special advantage over the other varieties of the breed.

Minorca. Minorca is noted for its length of body, large comb and long wattles. In fact it is the largest of the Mediterranean breeds. The long back has a significant slope downwards from the shoulders to the base of the tail, which is carried rather low and is well spread.

There are Black, White and Buff varieties. The Black and White varieties are further sub-divided into the single and rose-comb varieties. The most popular, however, is the single-comb Black Minorca, which has an attractive metallic black plumage and an unusually large comb. As in the Leghorn, the comb is erect but has six evenly and deeply serrated points. The blade of the comb has a tendency to follow the neck. In the female also the comb is large and six-pointed, the

front folding to one side and the rest to the other side of the head. The beak is black and the shanks and toes are black or dark slate.

This breed which was at one time even more popular than the Leghorn because of the superior size of its white eggs, is now dropping out of favour probably because of the decline in production. The standard weight in pounds is: cock 8; hen $6\frac{1}{2}$; cockerel $6\frac{1}{2}$; pullet $5\frac{1}{2}$.

Ancona. The Ancona is of the same general type as the Leghorn. The breed has both the single-comb and rose-comb varieties, of which the former is relatively more popular, although the breed as a whole is not so much favoured as the White Leghorn.

The plumage colour of Ancona is lustrous black with some of the feathers tipped white which give the bird a spotted appearance. The black surface-colour of the male has a greenish sheen, which is absent in the female. The main tail feathers and sickles of the male and the main tail feathers of the female are tipped with white. The primary and secondary wing feathers also show white tips. The under colouring is dark slate throughout. The beak is yellow with the upper mandible shaded somewhat black. The shanks and toes are yellow or yellow mottled with black. The standard weight in pounds is: cock 6; hen $4\frac{1}{2}$; cockerel 5; pullet 4.

3

CHOOSING A BREED

CHOOSING the right breed is a pre-requisite of successful poultry farming. Naturally the question "what breeds should be kept" confronts every prospective poultry keeper. Selection of suitable breeds is not merely a matter of individual preferences and requirements but a choice hedged in by such factors as the environment, husbandry conditions, marketing facilities and local prejudices. A novice is apt to underrate these vital factors and to base his choice on either lay biases or personal fancy, only to find later that a wrong choice has been made.

Fortunately for the poultry keeper there are many types, breeds, varieties and strains from which selection can be made to suit his needs. It is, therefore, advisable for every poultry keeper to become familiar with the characteristics and possibilities of different breeds. The description and potentialities of the various types and breeds have already been dealt with in Chapter 2.

The most important consideration in the choice of a breed is that it should be pure-bred and of a good strain. Pure-bred stocks are dependable for uniformity in type, colour and production, because they have been developed from generation to generation for these qualities. There is no point in taking risks with the non-descript or mongrel fowls, which cost just as much to maintain as the pure-bred birds but give a much smaller return, although under improved husbandry conditions even the mongrels may be expected to improve in their yield within a limited range. Each breed has several strains, some of which are more economical than the others as regards their productivity. Only the best strains, capable of yielding maximum returns under the given conditions should be selected.

There can be no two opinions about the advisability of specialising in only one or two breeds. By limiting the number of breeds the problems of housing, breeding and rearing the birds are simplified.

SELECTION OF BREED

For Egg Production. The selection of a breed depends naturally on the object in view. If the aim is purely egg production, only such breeds should be maintained as possess all the qualities of good egg layers, i.e., quick maturity, stamina and capacity to produce a large number of standard-sized eggs. Leghorns are good layers. A standard-sized egg in the context of the existing Indian conditions



FIG. 5. ASEEL (A MALE
WITH TWO HENS)



FIG. 6. A PAIR OF DESI
FOWLS (DENKI)



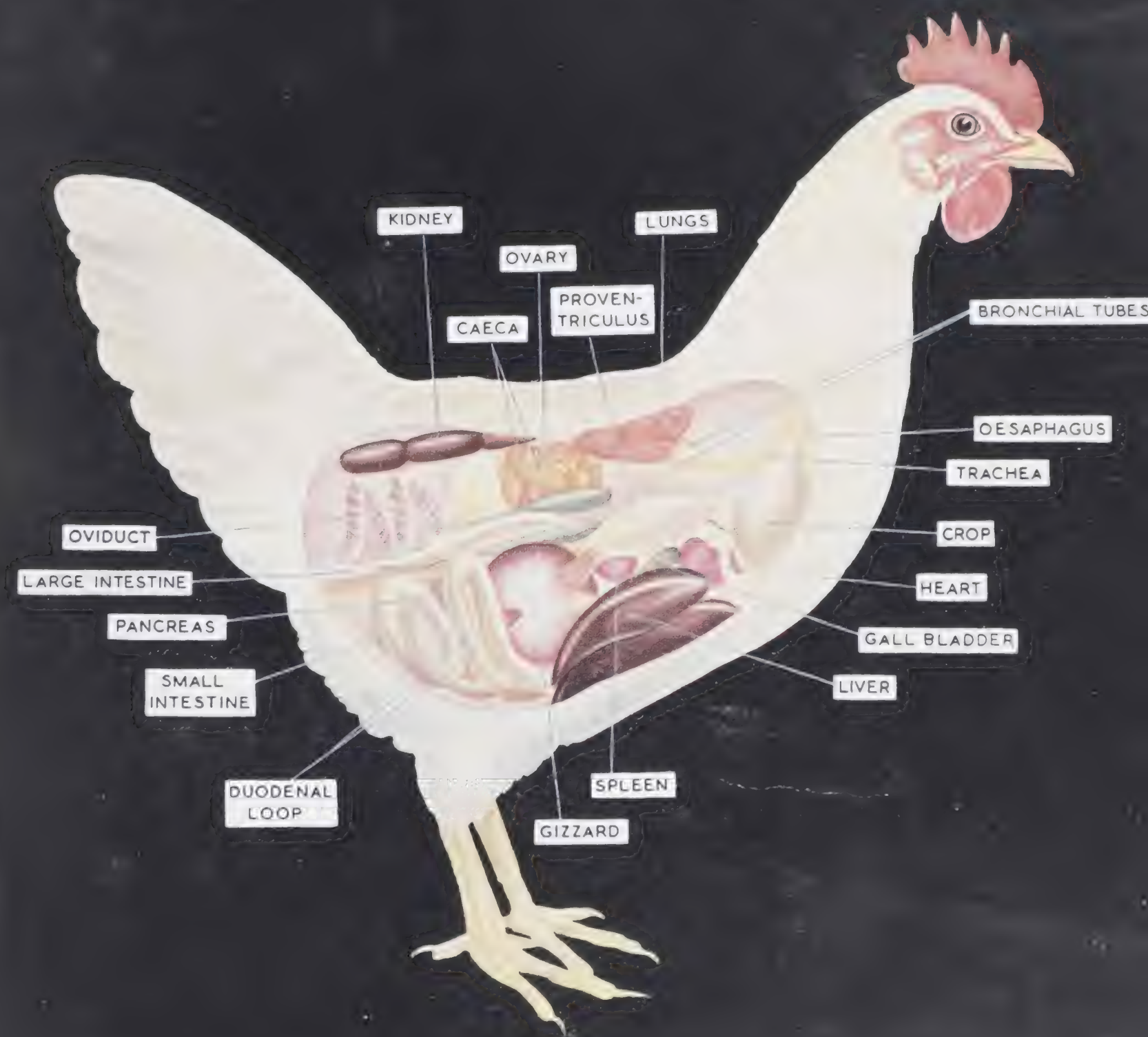
FIG. 7. A PAIR OF DESI
FOWLS (PITHICHERRY)



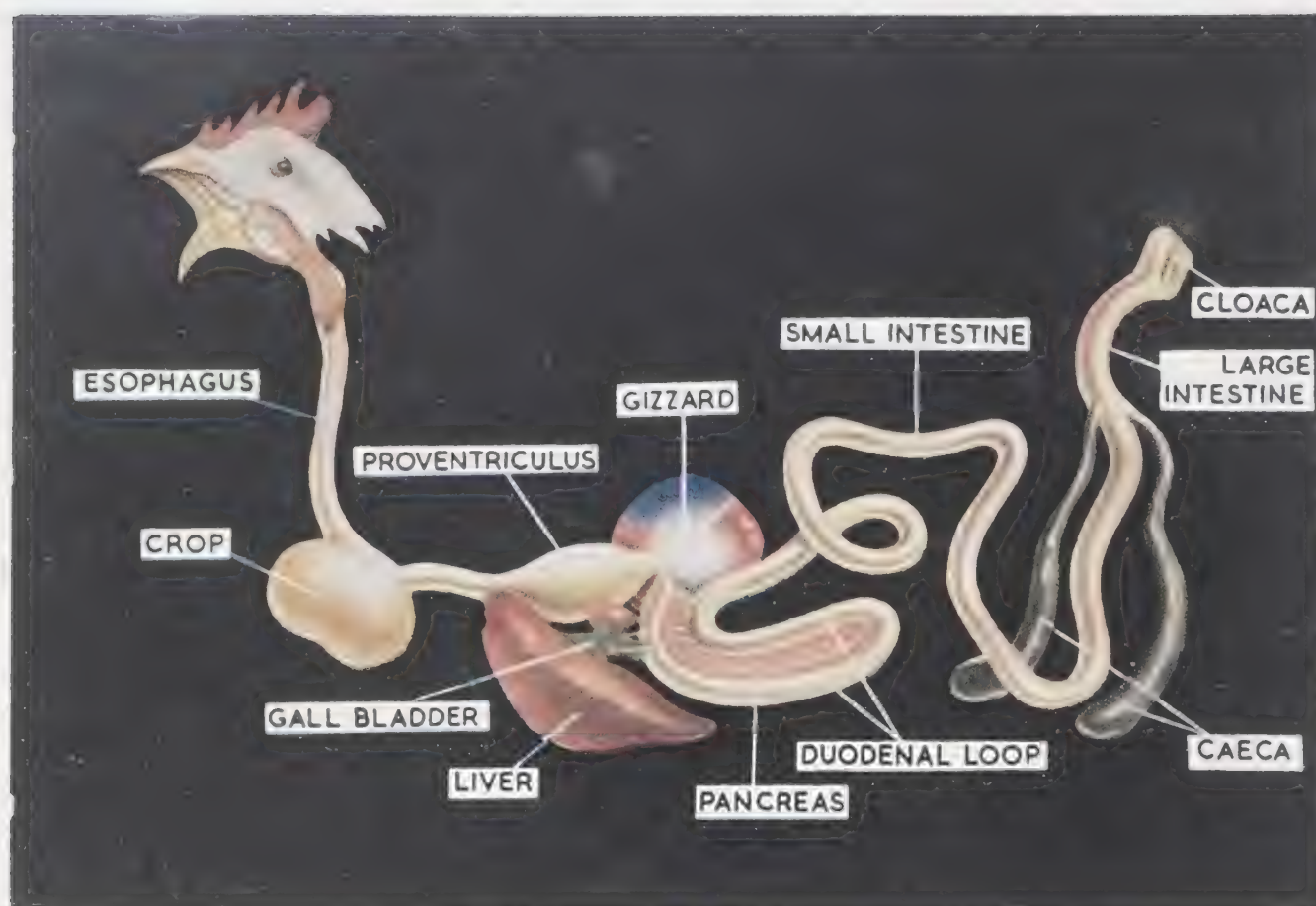
FIG. 3. A PAIR OF INDIAN RED JUNGLE FOWLS



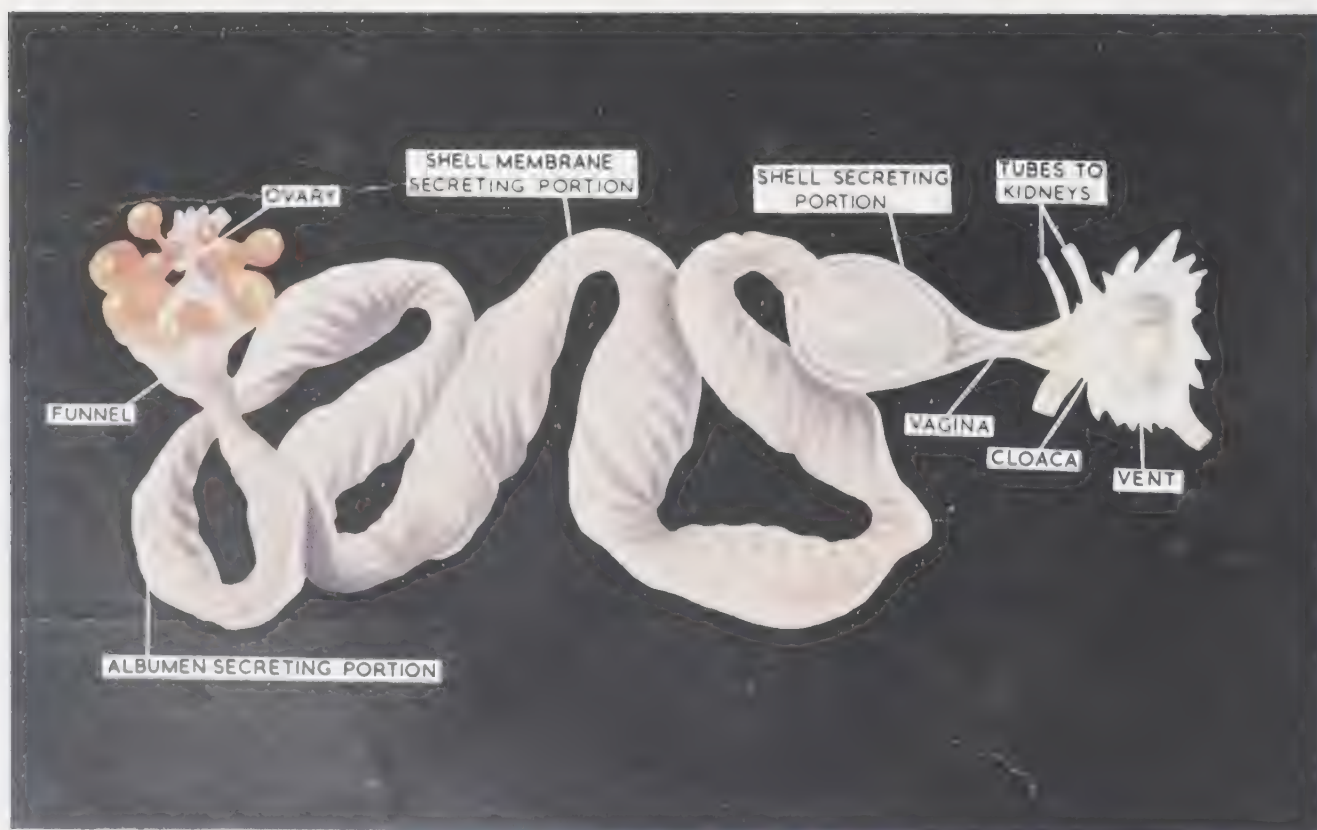
FIG. 4. A PAIR OF LIGHT SUSSEX



Inside of a fowl



a. Digestive System of a Fowl (*Dr. Salisbury*)



b. Egg Forming Organs of a Hen (*Dr. Salisbury*)

would weigh from $1\frac{3}{4}$ to 2 ounces. Eggs weighing over two ounces, especially when their production is at the sacrifice of numbers, are of no special advantage as they are not likely to sell at correspondingly higher prices.

For Table Purpose. There are breeds which are classed as meat or table breeds. New Hampshire is one such breed. These are generally heavy birds with plenty of flesh, but not good as layers. They are not very popular in the country as they do not give returns commensurate with the rearing costs.

Dual-purpose Breeds. The most popular breeds are the dual-purpose breeds, which besides being good layers are also profitable for table purposes. Rhode Island Reds and Australorps are good examples of dual-purpose breeds.

The most suitable weight of a table bird for India may be regarded as varying from $3\frac{1}{2}$ to 4 pounds. A small compact bird of this weight is preferred to a heavier one because, in the first place, it is comparatively cheaper and, therefore, within the means of an average consumer in the country; and secondly, it provides just enough meat for one meal for an average-sized family and, therefore, entails no waste, which in the absence of cold storage facilities, such as exist in Western countries, is an important consideration in poultry rearing and consumption.

Environmental Factors. Environmental factors, such as climate, soil and surroundings, also influence the choice of breed and management techniques. Breeds which may thrive well in hot arid regions may not do well in the humid regions. Consequently, breeds which thrive well in temperate climates and under the best husbandry methods should not be introduced without being tested as regards their suitability under conditions peculiar to the area.

Local Prejudices. Certain considerations of purely local character cannot also be ignored in deciding about the breed. In some areas, where the population consists mostly of strict vegetarians, the use of eggs and meat is a taboo. In such areas poultry keeping cannot be a successful venture. In certain other areas there may be no objection to the use of poultry and poultry products, but there is some prejudice against keeping white coloured breeds, whatever their qualities and virtues may be. Such a prejudice is born of a fear that the white fowls suffer heavy losses, especially on account of predators, which are very common enemies of poultry in the country. It has been found that in a flock of both coloured and white birds, even among the *desi* stock in the villages, it is generally the whites that fall easy prey to the predators, perhaps because of the ease with which they are recognized. This has led to a belief, almost bordering on superstition that white colour is unlucky; and hence the reluctance of poultry keepers to take to white coloured breeds. In such areas it is advisable to select from among the coloured breeds. The Brown Leghorn for instance may find a popular acceptance where there is prejudice against the White Leghorn. Similarly in certain areas or regions white eggs are not as popular as the brown or tinted ones, and the latter fetch better prices than the former. In such regions a breed laying white eggs is at a disadvantage.

STRUCTURE OF THE FOWL AND FORMATION OF EGG

STRUCTURALLY the chicken (fowl) is an interesting creature, and is among the most highly specialised of vertebrates. In common with other birds, it has a coating of feathers, no teeth, sock-like appearance, and legs with spurs (Fig. 8). It possesses a comb which distinguishes it from other birds. It is a shortlived creature having a relatively high breathing and pulse rate, and body temperature which in adult birds varies from 105°F. to 190°F.

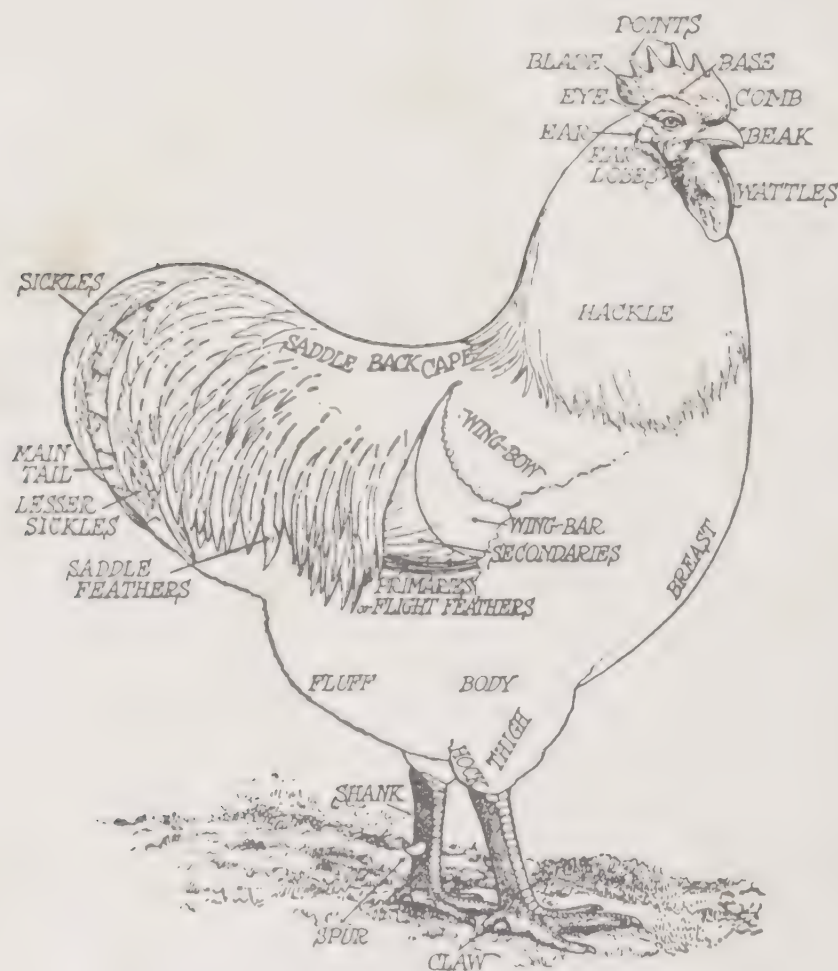


FIG. 8. EXTERNAL PARTS OF A FOWL (From 'Poultry Husbandry' by Morley A. Jull)

STRUCTURE OF THE FOWL AND FORMATION OF EGG

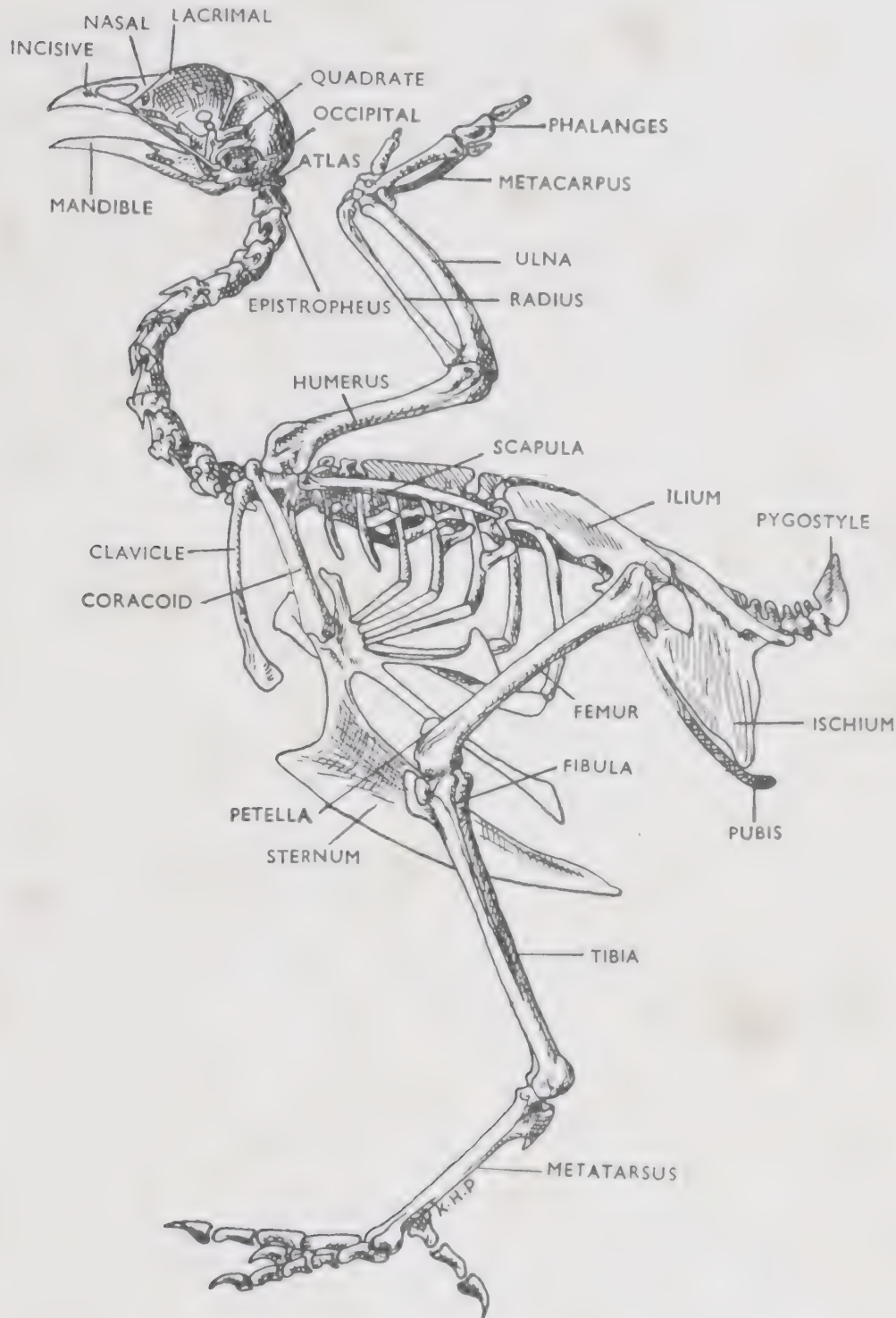


FIG. 9. SKELETON OF A FOWL (From 'Poultry Husbandry' by Morley A. Jull)

Feathers. Feathers help to protect the bird from physical injury and to keep the body warm. The wing feathers are essential for flight. The annual renewal of the feather coat, generally known as 'moult', is a great physiological strain to the fowl, as the feathers account for 4 to 9 per cent of its live-weight, depending on the age and sex of the bird.

Skin. The skin, of which the comb, wattles and ear-lobes, as well as the scales on the shanks and toes are specialised developments or out-growths, is free from glands except a single oil gland located at the base of the tail. The presence

of a pigment—the lipochrome pigment—gives the skin a yellowish colour, while its absence makes for white colour. Black colour of the shank is due to the presence of another pigment, called melanin, in the epidermis.

Skeleton. The skeleton of the fowl is compact, light in weight but very strong (Fig. 9). Many of the long bones are hollow, and on that account light. Several of them are fused together to form very strong structures to which the large muscles used in flight are attached.

Respiratory System. The respiratory system of birds differs entirely from that of other animals (mammals). The lungs are attached firmly to the thoracic wall and cannot expand. The active part of respiration is expiration (breathing out), whereas in mammals the more vigorous part of breathing is inspiration (breathing in). Associated with the lungs are four pairs of air sacs placed on either side of the body ranging in position from the neck to the abdomen. The sacs besides opening into the lungs communicate directly with the cavities of several of the long bones of the body.

The voice of the fowl is produced in the *syrinx* or lower larynx, located at the bifurcation of the trachea into two bronchi.

Digestive System. The digestive system of the fowl includes the alimentary tract and the accessory organs (Plate 2 a). In some respects it differs materially from that of mammals. There are no teeth, but instead the fowl has a horny beak and a gizzard, the former being used in breaking up much of its natural food, while the latter serves to grind the food. The gullet or oesophagus is an elastic tube which is enlarged to form a crop, and opens into the glandular stomach or proventriculus. The crop serves as a storage pouch for the food and enables the birds to eat large quantities. The gizzard is an important organ and varies in condition according to the type of food the birds eat. Chicken fed exclusively on all-mash rations have softer and less muscular gizzards than those fed exclusively or largely on hard grains.

A greater part of the alimentary tract consists of the small intestines and large intestines. The first section of the small intestine is called the duodenum into which open two ducts of the pancreas, which lies in between the duodenal loop. The liver communicates with the duodenum by means of two or three ducts, one of which connects the gall bladder which stores the bile secreted by the liver. The spleen is a small reddish brown organ which lies in the triangular space formed by the proventriculus, gizzard and liver.

The ileo-caecal valve is at the junction of the small and large intestines. Two blind diverticula or caeca about 4 to 6 inches in length arise from the ileo-caecal valve. The large intestines are relatively short, and lead to the cloaca into which open the ureters from the kidneys and the reproductive ducts. The cloaca is immediately followed by the vent, the terminal portion of the alimentary system.

Urinary System. The urinary system comprises the kidneys, of which there are two, each consisting of three lobes. These lie embedded underneath the girdle of the hip bone. The urine from each kidney is discharged into the cloaca by

means of the ureter. In birds urine is excreted along with the faeces and there is no liquid urine passed as such, as in mammals.

Reproductive System. The reproductive system in the male consists of a pair of testes, each of which is connected to the cloaca by means of a tube called 'Vas-deferens'. The testes are small, oval, elongated, yellowish-white bodies, situated at the anterior end of the kidneys. The left testicle is usually somewhat longer than the right. The reproductive cells or spermatozoa are formed in the testes and conveyed to the Vas-deferens where they become motile. The Vas-deferens open into small ducts lying directly over a groove in rudimentary copulatory organ situated in the cloaca.

The egg forming organs of a female (Plate 2 b) consist mainly of the ovary and the oviduct. The ovary is usually single, located to the left side of the body, close to the backbone just behind the lungs. However, some birds are occasionally observed to possess two functional ovaries and oviducts.

The ovary is like a bunch of grapes in form, and when active is somewhat yellowish in colour. Within it are numerous yolks or ova, varying in size from a microscopic dot to the yolk of a normal-sized egg. As many as 3,600 yolks or ova have been observed in the ovary of a single hen. Each ovum is enclosed in a sac called follicle, and is capable of developing into a full-sized yolk. When the ovum reaches its maximum size, the follicle breaks along the suture line allowing the yolk to escape.

The oviduct is a long, white, coiled tube occupying a large part of the left half of the abdominal cavity and extending from the ovary to the cloaca. The anterior end of the tube, which is funnel-shaped, is spread out beneath the ovary to receive the ova as and when they are shed. The posterior end of the oviduct forms the cloaca, through which the egg is expelled. The oviduct consists of five distinct parts; funnel or infundibulum, magnum or albumen secreting portion, isthmus, uterus and vagina.

FORMATION OF EGG

The yolk which is popularly known as the yellow of the egg, with its enveloping thin membrane, the vitelline membrane, constitutes the ovum. Embedded in the surface of the ovum (yolk) but under the vitelline membrane is the germ spot.

Each yolk is enclosed in a membranous sac called the follicle. As the yolk increases in size the follicle also enlarges; and as soon as the yolk is ready to be liberated, the follicle bursts. The yolk so liberated is caught by the funnel-shaped opening of the oviduct and during its passage through the upper part of this tube the glands situated in its walls secrete and supply nearly 50 per cent of the albumen that is found in the egg. This is the thick or dense albumen. In addition, two spirally coiled cords or the chalazae which help retain the yolk in the egg in position are also formed here.

The shell membranes are the next to get deposited; and this happens in the isthmus as the egg passes through it to the uterus, where the rest of the albumen,

which is thinner, is secreted and the outer shell added. By the time the egg reaches the vagina, its formation is completed. The finished egg is then expelled through the cloaca.

It takes approximately 3 hours for the ovum to pass through the first portion of the oviduct where the thick albumen is secreted. It spends about an hour in the isthmus and from 18 to 22 hours in the uterus and vagina. Here the shell and shell pigment are deposited on the egg before it is expelled through the cloaca. Altogether, it takes from 22 to 26 hours from the time the ovum breaks away from the follicle until the finished egg is laid.

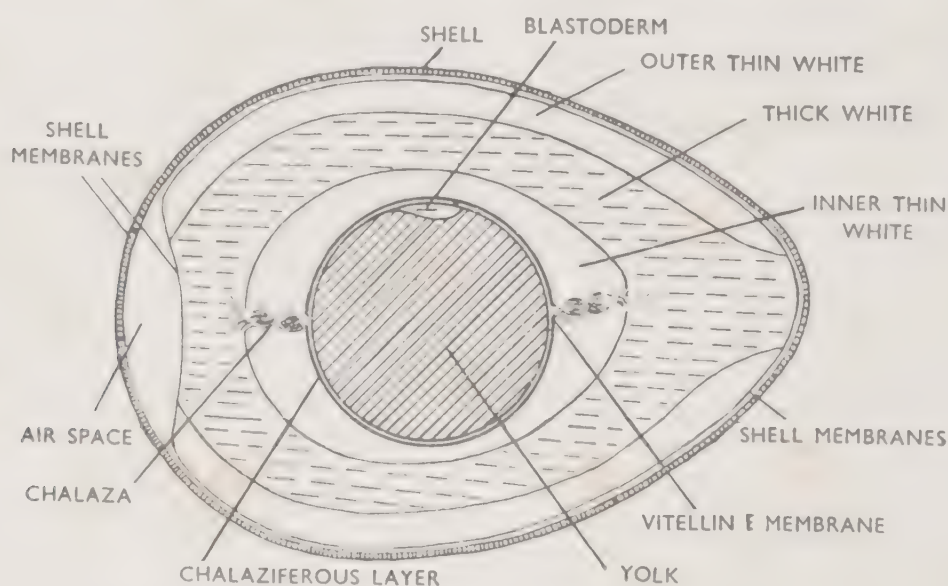


FIG. 10. STRUCTURE OF EGG. (From Bulletin No. 148 of the Ministry of Agricultural and Fisheries, London, U.K.)

STRUCTURE OF EGG

The egg is one of the most wonderful things in nature, not only as an article of food, but also because of its capacity to develop and produce independent life under favourable conditions.

The normal shape of the egg is irregularly ovoid in that one end is broader and somewhat flatter than the other and that the maximum diameter lies slightly nearer the broader end. This difference in shape between the two ends is of considerable significance in the development and hatching of the embryo.

Figure 10 illustrates the structure of an egg. The principal constituents with their proportions to the gross weight of the egg are: shell and shell membranes, 12 per cent; albumen and chalazae, 56 per cent; and yolk, 32 per cent.

Shell. The shell consists mainly of calcium carbonate, and forms the protective covering for the soft contents within. It is hard and rigid, with thousands of very minute tubular tunnels—the pores—which allow interchange of moisture and gases like oxygen and carbon dioxide between the egg contents and the outside atmosphere. The number of pores per unit area of the broad end is much larger than that found anywhere else on the surface of the egg.

There are two principal layers of shell. The outer layer is thin, relatively dense and compact, and is believed to provide a partial defensive mechanism against the entry of bacteria and other unwanted and undesirable micro-organisms. The defensive mechanism is, as already stated above, only partial in that it cannot prevent such organisms from entering an undamaged egg once it has been laid. The conditions that seem to favour the entry of bacteria are (a) damp and dirty nest boxes, and (b) damp cleaning of dirty eggs. The inner layer of the shell is much more open and granular in structure and, besides assisting in maintaining the strength and rigidity of the shell, serves as a source of calcium for the growing embryo. There are two shell membranes, both thin and tough, which lie adjacent to each other and to the shell, except at the broad end where they separate leaving the outer membrane in contact with the shell, while the inner one is so curved as to leave an air space in between. The outer membrane can only be separated from the shell with the greatest difficulty.

Albumen. The albumen or white is not uniform throughout, but is made up of four different layers. The outer layer of the thin white is immediately inside the inner shell membrane, and forms about 20 per cent of the total white. This is in contact with the shell membrane except at the two ends of the egg where the thick white comes in contact with the membranes. The thick white makes up about 50 per cent of the total white. Enclosed within it is the inner layer of thin white. The chalazae are nothing but coils of thick white, twisted in opposite direction, arising from the thick white layer at each end and terminating in the chalaziferous layer, a very thin, film of dense white that surrounds the vitelline membrane that encloses the yolk. The white has two functions: (1) it acts as a shock absorber, protecting the embryo and yolk, from damage, and (2) it serves as a source of food for the growing embryo. The chalazae serve as additional shock absorbers and play an important part in maintaining the correct position of the yolk within the inner layer of the thin white.

Yolk. Besides the female germ cell, the yolk is the only part of the egg that has its origin in the ovary; the albumen, shell membranes, and the shell are added one after another during the passage of the egg through the oviduct. The yolk consists of the female germ cell (blastodisc), and a rich store of food materials, all of which are enclosed within the vitelline membrane. The female germ or blastodisc cell is present in all eggs, but only becomes active and capable of development after it has been fertilized by the male germ cell or sperm. For the purpose of incubation, therefore, only fertile eggs are of any value. The clears or 'infertiles' cannot develop into chicks and should be disposed of as soon as possible.

POULTRY BREEDING PRINCIPLES AND PRACTICES

POULTRY breeding, as a scientific practice, is relatively a recent development and is concerned with the reproduction and improvement of domestic fowls. The superior productive capacity of the modern hen, in regard to the number and size of eggs as compared with that of its ancestor, i.e. the jungle fowl, can be attributed to two factors: (1) environment, and (2) improved breeding methods. If birds are to develop their inherited qualities to the maximum extent, they must have favourable environmental conditions.

Breeding practices aim at genetic improvement of the birds through successive generations. The breeders should have intimate knowledge of the various characteristics or qualities of different breeds, and should be able to make proper selection of the breeding birds. It is also necessary for him to have a working knowledge of the science of breeding. Since the ultimate object of poultry breeding is to improve birds in those qualities which have a definite market value, such as increased egg production and improved quality and quantity of meat-yield (and in the case of birds meant for exhibition, the perfection of body type and plumage colour), the success of a breeder in evolving valuable strains would depend on how best he can combine the desirable qualities to a high degree.

The quality standard of a strain of birds is determined by the capacity of the individuals in that strain to produce a given product at a profit. Thus, a strain of laying birds must be able to convert the feed into a heavy yield of high quality eggs. Mere heavy feed consumption does not in itself guarantee heavy production. The mongrel or the poorly bred and the *desi* hens are often voracious eaters, but because they are not bred for egg production they do not lay a correspondingly large number of eggs. The efficiency of feed consumption and its ultimate transformation into eggs or meat is obviously an inherited trait and can only be reproduced in succeeding generations by careful selection, breeding and management.

PRINCIPLES OF BREEDING

The fundamental principles of scientific breeding are briefly given below:

(1) Breeding should be purposive. The breeder should have a clear idea about the standard of excellence to which birds are to be bred—it may be in regard



FIG. 11. TRAP-NESTING OF BREEDERS



FIG. 12. LEG BAND FOR IDENTIFYING BREEDERS



FIG. 13. MARKING EGGS FOR
PEDIGREE BREEDING



FIG. 14. IDENTIFICATION OF CHICKS BY
WING BAND



FIG. 15. HYBRIDS (AUSTROWHITES): AUSTRALORP COCK AND WHITE LEGHORN HEN CROSS



FIG. 16. HYBRIDS: RHODE ISLAND RED COCK AND LIGHT SUSSEX HEN CROSS

to size, weight, egg production, meat quality, colour pattern or a combination of these factors.

(2) Breeding should be done from parents which conform as closely as possible to the required standard. In selection and mating, all individuals which fail to possess the desired standard should be discarded.

(3) The parents selected for breeding should also be as nearly pure-bred as possible. Such birds are more likely to breed true.

(4) Birds selected for breeding should be studied carefully with a view to mating them in such a manner that any faults which the parents possess may be corrected in the progeny. This is difficult to accomplish, but is the only means whereby improvement in the succeeding generations is possible.

(5) Selection must be practised continually and carefully, both in regard to mating and culling of inferior progeny, from the hatching time to maturity. This is an important single factor ensuring the success of any breeding operations.

(6) Environment plays an important part in breeding. Conditions that are as near the ideal as possible should be created in respect of housing, feeding, sanitation and general care.

Pedigree Breeding. An important practice in breeding is the building of pedigrees. This is done by keeping proper records, by which it is possible to know the exact parentage of the progeny. It is only by pedigree breeding that the efficiency of matings can be measured, and the selection and mating operations modified to ensure improvement. Keeping of accurate mating and breeding records is necessary for, (1) knowing the ancestry of resulting progeny, (2) determining the breeding efficiency of the birds used in mating, and (3) building up a line or strain of birds possessing the desired characteristics.



FIG. 17. PUNCH MARKS IN THE WEBS OF THE FEET

For pedigree breeding to be successful, the steps to be followed are: (1) identification of the adult breeders by such simple methods as leg bands (Fig. 12) or punch marks in the webs of the feet (Fig. 17); (2) trap-nesting of the breeders to determine the eggs laid by individual hens in the various matings (Fig. 11); (3) marking eggs as and when laid with a distinguishing mark to identify the hen laying them (Fig. 13); (4) hatching the eggs from each individual hen together, either in special wire compartments or in muslin bags, and (5) identifying chicks by leg bands, wing bands (Fig. 14) or web marks.

PRINCIPLES OF MATING

In mating stock, the number of females to each male depends on the breed, the class of stock, the time of the year, and the age and condition of the male. A larger number of females may be allowed for each male in small active breeds

like the Leghorns than in the heavier breeds such as the Rhode Island Reds. A young cockerel can be given more females than an old cock. More females can be allowed in the mating pen during spring than during winter.

Matings are of several kinds, viz., (1) pen mating, (2) flock mating, (3) stud mating, and (4) alternating males. In recent years artificial insemination is replacing natural mating in the poultry breeding plans, and has proved to be of great help in extending the services of proven sires to a very large number of hens. Artificial insemination is also useful when breeding has to be done under the battery system of poultry keeping.

Pen Mating. Pen mating is resorted to in pedigree breeding. In this system each male is kept separately in a pen with several females. As a rule 10 to 15 females can be kept with a cock in the case of lighter breeds, and 8 to 10 females in that of heavier breeds.

Flock Mating. In flock mating several males are included in a large group of females. One male is provided for every 15 to 18 females of the lighter breeds, and 12 to 14 females of the heavier breeds. When flock mating is resorted to under confined conditions there is a tendency in the males to fight each other; and generally one male becomes the aggressor preventing others from mating. This may affect the fertility seriously, and can be remedied by removing the aggressive male. On a free range, however, several males may be kept with a large flock of females. Under ordinary farm conditions and more especially when no pedigree breeding is undertaken, flock mating is preferred, as it permits housing a large number of fowls as one unit thereby reducing overhead costs.

If full-grown cocks are used as breeders in either pen or flock matings, fewer females should be allotted to each male—not more than 10 in the case of lighter breeds and not more than 8 in heavier breeds. This is because the cocks are not so active as the cockerels.

Stud Mating. On the analogy of matings in larger animals, it is considered that among the poultry the mating of a male more than once within a given period of time is a waste of his powers. To avoid this, stud mating is adopted. This consists of keeping the males and hens in separate pens or confining the males in separate coops in the pen of the females. The hens are let in to the male's pen one by one at intervals, and after mating are removed to their own pen.

Alternating Males. This method of mating is resorted to with the minimum of males available. Twice the number of hens that would ordinarily be allowed for one cock are confined in a single pen. Two males are used for mating, but only one is allowed to run with the hens at a time for one full day, while the other is confined to the coop. The following day the male that had been employed is removed to the coop, and the second one is let in with the flock. This method, like the flock mating, is impracticable in pedigree breeding, because the paternity of the offspring cannot be determined.

SYSTEMS OF BREEDING

It is desirable for a practical breeder to become familiar with the various

systems or methods of breeding. The systems of breeding generally employed for improving flocks are known as (1) inbreeding, (2) line breeding, (3) out-crossing, (4) crossing, and (5) grading.

Inbreeding. The mating together of close blood-relations, such as father and daughter, mother and son, or sisters and brothers is called *inbreeding*. This practice, unlike inbred strains of some farm crops, has not proved satisfactory with poultry. After several generations of close inbreeding, a decided loss in egg production, hatchability, rate of growth, and longevity (viability) of stock is noticed.

Line Breeding. Systematic inbreeding which involves the repetition of certain desirable individuals and their offspring is known as *line breeding*. The aim of line breeding is to fix definite characteristics in the offspring by constant mating of the male with successive generations of the females in the line of descent. The general practice followed in line breeding is to mate together individuals which are not related closer than the first cousins. For example, a male may be mated to his daughters because he comes from a high-producing female and the daughters are high yielders. From this mating of father and daughters, a generation is produced called F_1 generation. The father may then be mated to F_1 females. The object of such a plan is to fix high egg production in the strain. But even this should not be continued indefinitely as it may prove detrimental to the strain.

Out-Crossing. The mating of birds of the same variety but of different strains is called *out-crossing*. It is of special value when a certain strain is weak in a particular trait in which another strain of the same variety is superior. For example, one strain of White Leghorns may possess high egg production characteristic, but the eggs may be of small size. Another strain of the same breed and variety may be only reasonably good egg producers, but may lay eggs of large size. By crossing these two strains, it is expected that while egg production does not suffer materially egg size will improve.

Crossing. The mating of individuals of different breeds and varieties is called *crossing*. The resulting progeny is called cross breed or hybrid (Figs. 15, 16, 19). Out-breeding within the same breed as already mentioned above or crossing between breeds result in hybrid vigour in the progeny and is known as *heterosis*. Heterosis or hybrid vigour is the superiority of cross-bred progeny over the best of their inbred or relatively more pure-bred parent breed. The superiority of the cross-bred bird over its pure-bred parents is in regard to hatchability, chick viability, sexual maturity and egg production.

The discovery of heterosis, first demonstrated successfully in the breeding of hybrid maize, has very much changed the poultry breeding policy in many of the advanced countries. Pure-breeding is, therefore, not the only way of achieving success in poultry breeding. Crossing between birds with the aim of using the F_1 for commercial egg production along with others, like *criss-crossing*, *three-way crosses* or *incrosses* has become very popular in recent years.

Grading. Grading implies the mating of pure-bred males with the females of a mixed flock. This is a very useful system enabling a mongrel flock to be greatly improved by the use of pure-bred males (Figs. 20, 21). This method is, therefore, of

great significance in any plan of improving non-descript and uneconomical type of indigenous poultry, and is particularly serviceable for improving poultry in villages.

SEX-LINKED CROSSES

Most of the characters of domestic poultry follow the ordinary Mendelian rules of heredity, according to which each parent transmits its character equally to both sexes of the offspring. There are, however, certain characters which the hen transmits only to her male progeny. Such characters are known as sex-linked characters. The discovery of this fact has played a considerable part in shaping poultry practices in many countries.

Of the few sex-linked characters, only four are of commercial value, namely: (1) silver plumage (Light Sussex) as opposed to gold (Rhode Island Red); (2) barred plumage (Barred Plymouth Rocks) as opposed to unbarred; (3) slow feathering (heavy and utility breeds) as opposed to rapid feathering (White Leghorn); and (4) certain forms of light shank colour as opposed to dark shank colour.

Silver-Gold Pair of Characters. A Rhode Island Red (gold) cock mated to a Light Sussex (silver) hen produces silver cockerel chicks and red pullets, and what is more interesting is that the sexes of the chicks can be easily recognised at the hatching time on account of the distinctive colour of the downs in the two sexes.

Barred-Unbarred Pair of Characters. An unbarred cock such as Black Minorca, Rhode Island Red, Brown Leghorn or Light Sussex cock mated to a Barred Plymouth Rock (barred) hen produces sex-linked chicks whose sexes can be distinguished in the downs at hatching. The male chick shows a light patch on its head, which is absent in the pullets or female chicks.

Slow-Rapid Feathering Pair of Characters. When a cock of the rapid feathering breed such as the White Leghorn is crossed to a hen of a slow feathering breed like the Light Sussex or Rhode Island Red, the resulting progeny shows

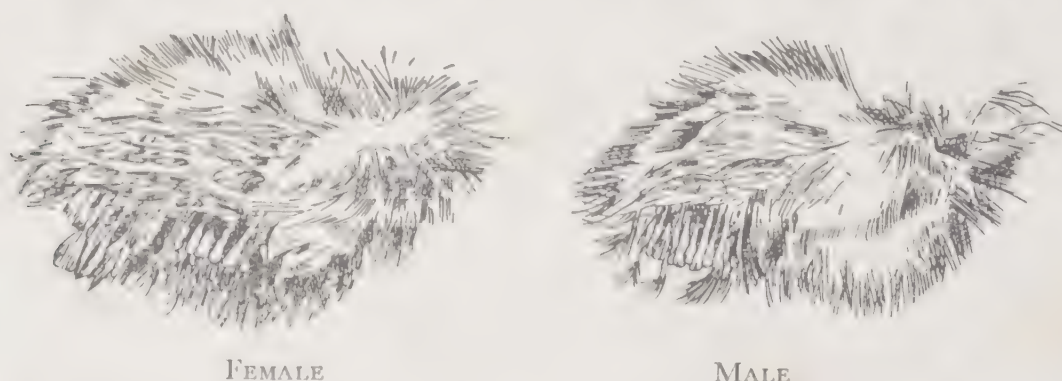


FIG. 18. THE SLOW AND RAPID FEATHERING PAIR OF CHARACTERS IN THE SEX-LINKED FEMALE AND MALE CHICKS

sex-linked characters. The female chicks show at the time of hatching the primary feathers of the wing clearly pushing out, while the male chicks show relatively undeveloped primary quills (Fig. 18).



FIG. 19. HYBRIDS: NEW HAMPSHIRE COCK AND LIGHT SUSSEX HEN CROSS



FIG. 20. UPGRADED FIFTH GENERATION PULLETS (PROGENY OF INDIGENOUS HENS MATED TO AUSTRALORP COCK TOGETHER WITH A PURE-BRED AUSTRALORP COCK FOR FURTHER UPGRADING)



FIG. 21. GRADED PULLETS (PROGENY OF INDIGENOUS HENS MATED TO BARRED PLYMOUTH ROCK COCK)



FIG. 22. BIRDS SHOWING POOR FEATHERING (CHICKS MARKED A, B, C, D, IN THE FLOCK ARE POORLY FEATHERED)

Light Dark Shank Colour Pair of Characters. When hens of a light shanked breed like the White Leghorn and White Wyandotte are mated with a cock of a breed with willow or slaty shanks like the Campine, there is generally sex-linkage, the cockerels having light shanks and the pullets dark shanks. This sex-linkage is not of such practical importance as the other three described above.

Sex-linked crosses make it possible for the separation of the sexes at hatching and the rearing of sexes separately right from the start, which fact is of much commercial importance.

BREEDING FOR EGG PRODUCTION

Production of eggs is the main economic factor in poultry breeding. Table-bird production is largely, though not exclusively, a by-product of egg production, while hatching eggs are required in large numbers each year for normal replacements and for the expansion of flocks by further breeding. The problem is, therefore, to develop egg-laying potentialities in the breeding stock. To a novice, all birds in a flock look alike and, therefore, lead to the assumption that all the birds should necessarily lay well. This is not so because several birds in the flock may, in actual practice, be found to be poor layers. In most flocks far too many birds of poor laying quality are allowed to remain year after year, because the breeder has not selected the birds on any logical basis. The constructive breeder, on the other hand, attempts by selection to segregate individuals having certain desirable qualities, and through intelligent mating, based on recognised systems of breeding, to assemble or produce in the progeny desirable combination of these qualities.

Egg Size. Besides the factors governing egg production, size of egg is also of great importance. Egg size and egg weight are synonymous terms, so far as fresh eggs go. The larger the size the heavier the egg is.

In any given flock of pullets the size of egg is apt to vary a good deal depending on the size of the bird. Generally, the smaller the bird the smaller the size of the egg she may lay; also the earlier she starts laying the smaller the first egg laid. One apparent reason for this is that the earlier a bird begins to lay, the smaller is its body size, or in other words, there is correlation between the body weight of a pullet and its egg size. The problem of maintaining good egg size is, therefore, intimately bound up with the problem of maintaining good body size. In order to obtain an egg size, equivalent of 24 ounces per dozen in the first year of production, it is desirable to have Leghorn pullets weighing at least 3 lb. and those of dual-purpose breed at least 5 lb. Good egg size and good production can be combined in the same strain provided proper selection of the breeding stock is followed. In planning a sound breeding programme, it is particularly important to select male breeders from among the families of high producers that lay eggs of good size.

SELECTION OF PARENTS

Selection, as applied to breeding, refers to the choosing of parents for raising stock. Skill in selection is the basis of successful breeding practice, and is of vital

importance not only for breed improvement but also for profitable poultry farming. It has been recognised that the breeding value of a bird depends on its inherent characteristics (genes), although there is no means of determining with certainty an individual's genetic make-up. The inherent characteristic, or the genetic constitution as it is generally called, may be considered under five categories: (1) individuality, including (in the case of females) the laying performance; (2) ancestry (pedigree); (3) sibs (sisters and brothers); (4) reproductive performance; and (5) progeny test. Of these the last two are by far the most dependable and, therefore, the most important.

INDIVIDUALITY

The individuality of a bird relates to the sum total of its characters and includes every detail of its make-up. While selecting birds for breeding the points to be examined in order of importance are first individuality followed by ancestry and sibs.

From the point of view of breeding for egg production individuality is considered under three main items, namely: (1) physique and temperament, (2) laying performance (in the case of females), and (3) breed and varietal characteristics.

Physique and Temperament. A good physique is an important consideration in breeding for production. Egg production is normal when there is an excess of vitality as well as of food, beyond what is needed by the hen herself. For heavy and continuous production this excess must indeed be large enough.

Laying Performance. A very important feature of the individuality of a breeding hen is her laying performance. This includes not only the total number of eggs she lays in her first year, but also the number she would lay in succeeding years, and not only her total production but the manner in which that production is distributed throughout the weeks and months of each year.

It is found that under suitable environmental conditions the annual egg production depends on the combined influence of four heritable characteristics: (1) maturity or age at the laying of first egg, (2) intensity or rate of production, (3) pauses in laying, and (4) persistency.

Age at First Laying: It has been recognised that the birds that start laying eggs early are better layers. A pullet that starts laying earlier costs relatively less to rear up to the age when she begins to lay than the one which starts laying later. The optimum age of maturity for White Leghorn and general-purpose pullets is 160 and 210 days respectively.

Rate of Laying: Laying rate, or as it is also called intensity, refers to the per cent of days in a given period, on which an egg is laid. As a rule the more eggs a bird lays in a given time, the better the rate or intensity of production. The most satisfactory index of egg production rate would appear to be the one calculated from the first egg to March 1st of the following year. It is found that pullets averaging about 27 per cent production during winter period averaged only 144 eggs in the whole year, whereas those with an average of 81 per cent averaged 241 for the year.

Pauses in Laying: By laying pause is implied a period of cessation in laying of one week or more. For purposes of selection for an improved laying performance, there are at least three types of pauses. These are: (1) environmental, (2) broodiness, and (3) winter pause.

ENVIRONMENTAL PAUSE: Environmental pause refers to those brought about by bad management, accidents, inclement weather, etc. Susceptibility to environmental changes may have a genetic basis. It is observed that the hens of some strains stop laying under environmental changes, while those of others can stand such changes well.

BROODINESS: Broody pause occurs when a bird goes broody, which is a hereditary character. The light or the Mediterranean breeds are generally non-broody and the Asiatic breeds are broody in character. The English and American breeds which are derived from these two extremes of broody breeds are intermediate in this regard. The extent to which broodiness occurs in modern dual-purpose breeds depends on the strain rather than the breed. Broodiness is not entirely unknown in light breeds. The losses in egg production arising from broodiness are considerable, and selection of birds apropos this character should, therefore, receive careful attention.

WINTER PAUSE: Cessation of laying for one week or more during the period from the time of the first egg to the first day of March is called the winter pause, the environmental factor being excluded from consideration. This is a hereditary character and, therefore, while selecting birds for breeding care should be taken to eliminate those that have shown long winter pause.

Persistency: The tendency of an individual to lay late in the fall is known as persistency. It is associated with late moulting and is an important factor in a high annual egg yield. Persistency is a hereditary character and should be looked for in the selection of birds for breeding.

Breed and Varietal Characteristics. There seems to be no very close relation between the various types and colours and production. Other things being equal, the choice between two birds should be with the one which is most nearly in accordance with the breed and variety requirements.

The foregoing analysis of laying performance gives an idea of the characters for which selection should be practised. If a given female lays at a high rate, has no pauses and is a persistent layer, she may be expected to reach a high annual record.

ANCESTRY

Ancestry or parentage or pedigree should be an important consideration in selection. A good individual with a good pedigree should be given preference to an equally good individual with a poor pedigree.

SIBS (SISTERS AND BROTHERS)

In selecting birds for breeding the choice should fall on those whose sisters and brothers (sibs) are equally and uniformly good in those characters for which

selection is made, instead of choosing outstanding individuals among mediocre sisters and brothers or sibs.

REPRODUCTIVE PERFORMANCE

The reproductive performance of a breeding bird is assessed under three factors; (a) the fertility of eggs by the females, or of the sires; (b) the hatchability of the eggs; and (c) viability or the ability of the chicks so hatched to live.

Fertility. Reproduction is necessary for the perpetuation of any race and reproduction in poultry depends on the fertility of the egg. In order to obtain high percentage of chicks from the eggs set for hatching, good fertility should be ensured. Fertility is not, however, an inherited character. A male or female with apparently low fertility may produce a highly fertile progeny and *vice versa*. The meat types or heavy breeds are generally less fertile than the egg types or light breeds, and the ornamental types such as the Bantams are usually least fertile.

Several factors are responsible for poor or low fertility, such as poor housing, poor management or disease. Sterility or partial sterility on the part of the male (i.e. inability to ejaculate viable sperm), barrenness or partial barrenness on the part of the female (i.e. inability to lay viable ova), prejudices such as aversion or favouritism on the part of the male, or lack of the mating instinct in either sex are factors contributing to infertility. Over-fat birds and a male out of condition show poor fertility. Young males (cockerels) are usually more fertile than the old ones (cocks). Fertility drops in cold weather and severe summer.

Test for Fertility: It is advisable to test matings for fertility, especially in commercial poultry farming, in order to ensure maximum number of chicks from the eggs laid. Some males may prove sterile or they may fail to mate with some hens or *vice versa*. In pen matings, testing of fertility is of great importance. If the eggs are mostly infertile, an immediate change of males is indicated, before eggs are collected for hatching. It is, therefore, advisable to provide enough males in large flock matings, so that if any of them is sterile or less fertile, fertility may not materially suffer. Fertility, however, is an individual characteristic of both male and female and does not appear to be transmitted to either the males or the females of the offspring. It is, therefore, not a point of importance in making selection for purposes of breeding as ordinarily understood, while the removal of such birds from breeding may be justifiable on economic grounds. There appears to be no correlation between fertility and hatchability.

Hatchability. By hatchability is implied the percentage of fertile eggs which hatch. The hatching ability has been shown to be hereditary in the female line, and probably also in the male line. It is, therefore, necessary in a breeding programme to select females with high hatchability, and to mate them to cockerels from hens whose eggs hatched well.

Viability. By viability is meant the capacity of the chicks to live and thrive after they are hatched. For profitable poultry farming it is important that not only a high percentage of fertile eggs hatch, but also that the chicks hatched survive and thrive. It is a common observation of the breeders who keep records that while

the chicks from one hen survive and thrive well, those from another hen do not, although they be by the same sire and placed under similar environment and management. Similarly, chicks from two males mated with two groups of females, respectively, may show significant difference in their viability at the end of the rearing season, even when both groups of females are comparable in every way and their respective chicks are reared under identical environment and management. It is, therefore, necessary to discard any male or female which consistently shows either low hatchability or low viability not accounted for by any faulty incubation or rearing or other factors. Their progeny should also be eliminated from any subsequent breeding programme.

PROGENY TEST

As already pointed out, while assessing a given bird as a possible breeder, individuality, ancestry and sibs are considerations one has to go by. A good deal of reliability can be placed on these, but one must also be prepared for freakish incidents. There is, however, one reasonably sure basis for forming judgment about a bird's ability to transmit genes for desired characters to most or all of its progeny and that is by breeding it. The progeny test is the best test of breeding value. By progeny testing is meant a careful analysis of the results secured from various matings that have been made, in order that future matings may be made with greater certainty of desirable results. In other words, the selection of breeding stock based on the performance of the progeny is called the 'progeny test' method of breeding. Any mating that has given good results should be repeated, as far as possible. On the other hand, any males or females whose descendants have been uniformly unsatisfactory should be discarded.

BREEDING PROGRAMME

With proper knowledge of the principal factors which determine the laying ability of the birds, it should be possible to plan a sound breeding programme. The first step in the programme is to determine which of the different male birds have proved to be the best breeders. The female progeny of one male should be compared with that of the other on the basis of the major factors described above. Having determined which male bird proved to be of superior breeding-worth, the breeder's next step is to compare the female progeny of each of the hens mated to a good quality male.

Sires and dams that have proved to be of outstanding breeding-worth should then be used for as many years as possible. Also, the progeny should be given preference at the time of selection of future breeders. Since the average sire and dam are relatively short-lived, it is necessary to adopt the best system possible in the selection of younger birds for breeding purposes, especially cockerels which should be chosen from the families in which the full sisters have shown outstanding performance.

There are three important points which should be remembered: (1) Individual records of egg production are of relatively little value in determining a

female's breeding ability (in other words, a bird that has laid 210 eggs during her first laying year may prove to be just as good a breeder as a bird that has laid 310 eggs); (2) record of egg production of the dam and grandams of a male or a female is of limited value in determining the breeding-worth of the male or the female; and (3) breeding-worth of a male or a female is determined to a considerable extent by the egg production of its female offspring.

IMPROVEMENT OF VILLAGE POULTRY

Work done at the Indian Veterinary Research Institute, Izatnagar, has shown that by selective breeding of *desi* or village birds over a period of ten years it is possible to raise the average egg production to a level of 120 to 137 eggs of 1·7 ounces, as compared with the production of 134 to 167 eggs of 2 ounces from pure-bred exotic breeds kept under identical conditions of good management. The genetic improvement of village poultry through selective breeding is, however, a costly and tedious task. A more profitable short-cut to the improvement of the indigenous fowl, therefore, is to do upgrading with such exotic breeds as have adapted themselves to the local environmental conditions.

Having determined the most suitable exotic breed under the prevailing environmental conditions in a particular area or region, the next step is to decide on the best way of introducing this breed in the villages. There are three ways of doing it, viz., (1) by direct replacement of the indigenous or local fowls by the improved or exotic breeds; (2) by upgrading the indigenous breed through mating with a selected exotic breed, and (3) by cross-breeding.

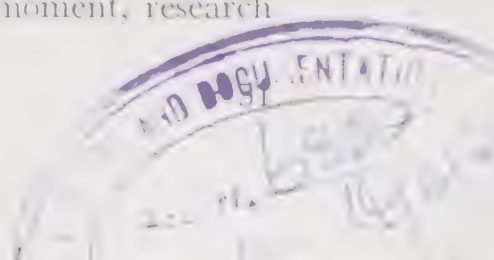
Direct replacement is not a practical proposition, not only because of the cost involved but also due to the inability of the average poultry keeper to afford the increased cost of feeding. Under the existing conditions in this country introduction of improved or exotic breeds can be undertaken only by those few who can afford to provide for their requirements.

Upgrading the indigenous or *desi* female fowls by mating them with males from selected exotic breeds, on the other hand, offers a practical and economically sound solution for improving the village stocks. The improvement in this case is gradual but marked from generation to generation and offers sufficient time to the poultry keeper for appreciating the benefits and the need for giving better attention in regard to feeding and management.

Skaller's Recommendations. In his paper 'Improving Poultry Production Through Breeding' presented at the F.A.O. Technical Meeting on Poultry Production, held in Poona in 1955, F. Skaller of the Commonwealth Scientific and Industrial Research Organization, Australia, has suggested certain practical steps for improving poultry in general and the village poultry in particular. In view of his extensive experience in the line in the tropics (Pakistan) where he had served as a Specialist Adviser previously, his recommendations are of special value to India, where conditions are almost identical. Relevant extracts from his paper are, therefore, reproduced below:

Implementation of Breeding Plan: "Provided we have made a decision on the desirable breed and on the breeding system by which the indigenous fowl is to be improved, it is then a task for the Extension Service to implement this policy. First, there must be State farms or accredited commercial farms which will produce the desired type of cockerels required for the grading up or cross-breeding work in the villages. As the next step, the distribution of these genetically superior cockerels to the villages has to be organised. Here, I would recommend the Indian system of organising 'key villages' for demonstration purposes, a system which was also suggested for an Improvement Plan in Pakistan. In such a village all indigenous cockerels should be removed and replaced by males of the desired breed. At the same time attempts should be made to improve husbandry conditions, and as an essential and preliminary step compulsory vaccination against *Ranikhet* disease should be carried out. Distribution of coloured spiral rings would assist in the culling of more than two-year old layers in addition to general culling policy of non-layers. Attention has to be drawn to the problem of broodiness. Depending on the breeds used, grading up and cross-breeding might result in the elimination of broodiness. This is desirable, provided the extension service has made provision to cope with this situation. The eventual aim would be to eliminate from the village all roosters at sexual maturity, and consequently the production of infertile eggs for the market, which is especially important in a country with high temperatures and poor transport between the places of production and those of consumption. Instead of breeding themselves, the cultivators should be educated to purchase unsexed baby chicks from the village or district hatchery. These hatcheries should receive fertile eggs from accredited multiplication farms which on their part would have to use for breeding roosters bred by the accredited or State breeding farms.

"There is probably economic justification for a few *large commercial egg farms*, situated in the vicinity of large concentrations of consumers' dwelling in the big cities. *Cross-breeds* between White Leghorns and one of the popular dual-purpose breeds, such as Australorps, Rhode Island Reds, or New Hampshires, are probably the most suitable type of birds for this type of production. Our experience at Warribee has shown that over a number of years cross-bred pullets from White Leghorns/Australorps consistently produced about 2 dozen eggs more than the average of their pure-bred parents. Criss-crossing has been mentioned before, and gives similar results; so do three-way crosses by using cockerels from a third breed on a cross-bred dam derived from mating two breeds. The combination of inbred lines within one breed, resulting in the production of so-called '*hybrid chicks*' in the U.S.A., has also given excellent results. But the production of these hybrid chicks required the very costly development of inbred lines. This procedure can, therefore, be recommended only where an adequate financial return above these costs can be expected by the sale of very large quantities of baby chickens. In the U.S.A. some of these breeding farms often sell more than 10,000,000 chickens a year. Further improvement in the performance of cross-bred chicks can be expected by *testing strains for combinability*. At the moment, research



is in progress in the U.S.A. and Australia to find out whether the system of *reciprocal recurrent selection* is advisable. Using this system, selection within pure-bred strains is based on the performance of their cross-bred progeny. It is still too early to judge if this system will be worth the extra costs involved.

“ However, in my opinion the main task of large poultry farms in Asia will be the production of cockerels for the grading-up work in the villages. To facilitate this work the *number of approved breeds* for a region should be *limited* to two—a light and a dual-purpose br d. They should be chosen, as being the most suitable for the particular environment of the region, from the following breeds: Improved, indigenous, White Leghorn, Australorp, Rhode Island Red, New Hampshire, and any new breed specially developed for this region. The tendency to import new breed from foreign countries, wherever they can be discovered, should not be encouraged.

“ Experience and theoretical consideration have shown that the *minimum effective size for a breeding flock* should be 500 pullets of one breed. Larger flocks are still better, because they give more opportunity for extensive sib and progeny testing, selection, and the best use to be made of outstanding proven sires. Also modern system of recording and analysis can be used economically in large flocks only.

Breeding Systems: “ Selection within the breeds on these breeding farms has to be based on the exact measurements of performance, and for characters with low heritability, such as egg number and adult viability, on family selection based on sib and progeny testing. *Different methods of selection* are possible and their theoretical value has been tested by Dickerson and Hazel. According to them the most efficient system is the ‘total-score’ method, i.e., selection on an index basis which combines different characters according to their economic importance and their genetic properties. Next efficient system is the ‘independent culling levels’ method, whereby animals are culled from breeding if they do not reach certain minimum targets set for a number of important characters, such as hatchability, sexual maturity, annual egg production, viability and egg weight. The least efficient system is the ‘random’ method whereby selection is carried on for a number of years for one character only until it is sufficiently improved to justify the commencement of selection for a second character.

“ The effect of different mating systems has been discussed earlier. Line breeding can be recommended as the safest method, whereby outstanding and proven sires used repeatedly leading to a mild form of inbreeding, but without adopting consistent and close inbreeding as a mating system, i.e., repeated matings of full-sibs or fathers with daughters.

“ The *economic value of a breeding system* depends not only on the rate of progress which can be expected from it, but also on the cost at which this progress can be achieved. Important cost factors are the time interval within which a certain amount of progress can be achieved, the costs of measuring, recording and analysing performance, and finally the financial returns which can be expected during the genetic development of the flock. For instance, although the combining

FIG. 23. EXAMINATION OF A FOWL
FOR WIDTH OF CHEST



FIG. 24.
EXAMINATION OF
A FOWL FOR
DEPTH OF BODY



FIG. 25. A GOOD LAYER SHOWING
GOOD DISTANCE BETWEEN
THE PUBIC BONES



FIG. 26. A NON-LAYER WITH PUBIC BONES CLOSE TOGETHER

of inbred lines might give good final results, this system is very costly, as the inbred lines, especially during the initial stages, are very poor producers, and have a low reproductive rate.

Measuring of Performance: "The cost of measuring performance can be reduced by measuring the mean performance of a group of related animals instead of measuring individual performance by trap-nesting or housing in single test pen or laying cages. On the whole, we are not so very much interested in the performance of an individual bird, but more in the mean performance of the daughters of one cockerel or of a dam, or their sisters and half-sisters. Hagedoorn recommends the testing of sires by housing all his daughters together in one shed and computing the financial returns from each family by recording quantity and prices of the food consumed by each pen and deducting these feed costs from the financial returns obtained by the sale of eggs produced by this pen during the pullet year. All that is necessary to carry out this system is a number of pens suitable to house about 40 to 50 daughters from each sire and the separate hatching and toe punching of each sire's progeny. Another way of reducing costs of measuring is by recording samples only instead of complete cycles of production. Several such systems have been tested and are described by Hutt as giving satisfactory results; such as trap-nesting three to five days per week instead of seven days, or by trap-nesting only a few days each month, or by recording only the early winter production and then again the production in late summer and autumn before the pullets go into moult. If breeding is done to improve egg weight, it is not necessary to weigh all the eggs of a hen. Samples taken at the critical period will render sufficient information to make good estimates. For instance, we in Werribee, weigh five alternate eggs from the first ten, then weigh one egg every fortnight until one egg has the weight of 2 oz. or more which is the standard target. The mean egg weight typical for the fully mature pullet is obtained later by weighing four eggs in weekly intervals during spring when the pullets are about twelve to fourteen months of age.

"The costs involved in the measurement and recording of egg production are justified only if sufficient and well trained staff is available to summarise and analyse these data so that they can and are used for selection and breeding work. It seems superfluous to point this out, but I have too often seen Government farms where trap-nesting is carried out but nobody ever had the time or inclination to analyse and make use of these records.

"Costs can also be reduced by measuring only those characters which are of importance to the present breeding programme. Characters which are suitable for measurements from the economic and genetical point of view are hatchability, chick mortality, sexual maturity, winter egg production, annual egg production during pullet and perhaps also second year, egg weight, body weight, and disease resistance or adult viability.

"Measurements and records taken by the breeder and under the environment of his own farm should be checked and supplemented by *State controlled laying tests*. These tests should be conducted in such a way that they give an indication

of the average economic performance of the breeder's flock. This is the aim of the random sample test, whereby samples of either eggs, or chickens, or growing pullets, are taken by an official from the breeder's flock and then tested under the uniform conditions of a State controlled testing station in competition with samples taken in a similar way from other breeders. The results of these tests can be used as a basis for the accreditation of farms and serve also as a guide to the prospective buyer of chickens or breeding stock''.

CULLING OF POULTRY

SUCCESS in poultry keeping depends not only on starting with good stock but also on maintaining its productivity at a high level by constant culling. Culling is, therefore, an essential part of efficient management of any poultry enterprise, and has a direct influence on profits. By 'culling' is meant the elimination from a poultry flock of those birds which, when judged from their physical characteristics, are found to lack the qualities for which they were bred, whether it be for egg production, table purposes, or for show.

Culling and selection are often regarded as synonymous terms, although in practice they have little in common. On a well managed farm both the operations are equally important. Selection consists in choosing the best individual from a poultry flock for breeding purposes, whereas culling means weeding out the uneconomical birds and the non-producers. Although one may start with a good stock, invariably there are some chickens that do not grow well, and some pullets that are poor layers. Such 'loafers' of the laying house—birds which are unprofitable to the poultry keeper—reduce the efficiency of the flock. They require practically the same maintenance cost and attention as normal-growing and good-laying birds, but give poor returns.

Culling is, therefore, very important and should be a continual operation on every poultry farm—small or large—throughout the year.

Equipment for Culling. Much time is wasted on poultry farms in catching birds for culling and other purposes. This can be obviated by including among the farm equipment a catching crate (Fig. 27) partitioned into two or three compartments. The crate can be easily carried from one poultry house to the other. It should be set outside the pop-hole and the birds driven into it, the slides being replaced when the crate is full. If the pop-hole is above the ground level, an adjustable unit as shown in Fig. 27, will provide a continuous passage from the house to the crate.

Preparation for Culling. Care should be taken not to frighten laying birds and growing stock. They should be handled carefully throughout the culling operation. To start with, birds should be confined to their houses and in order to reduce any undue excitement among them, the openings of the house such as doors and windows, should be either darkened by hanging sacks over them or closing them.

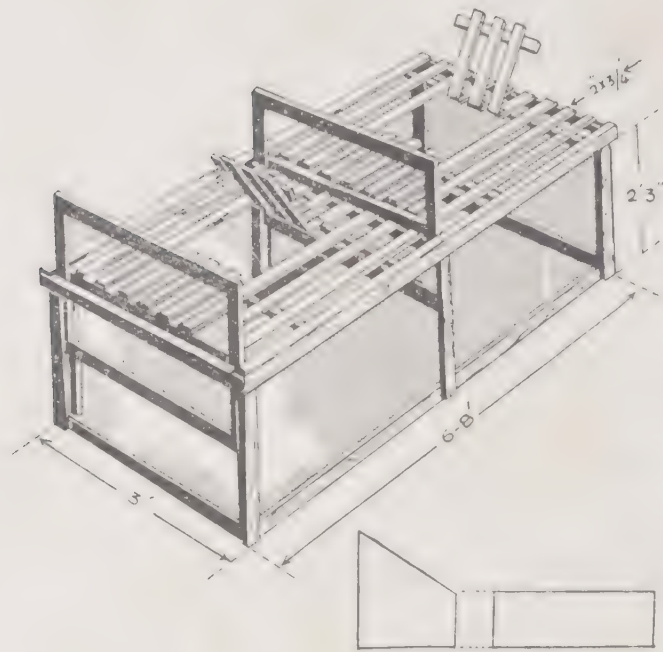


FIG. 27. CATCHING CRATE

One end of the catching crate is placed over the pop-hole or the exit of the poultry house and the birds are slowly driven into it—a few at a time. Birds kept intensively are best caught in the house by driving them from a corner into the crate. Catching hooks should be used with discretion as they may injure or upset the birds and throw them out of production. It needs a little practice to use the hook effectively; it should be kept low on the ground and quickly jerked back over the bird's shank above the foot.

While examining, the bird should be held in a natural position, its body resting comfortably in one hand leaving the other hand free to handle the head, wings, etc., in the course of an examination. Birds should be removed from and replaced in the crate head first.

CULLING GROWING STOCK

Poorly developed birds in a flock of growing chickens may be due to the inherently poor quality of the breeding stock from which they are obtained or to faulty feeding and or defective management.

The advantages of culling the growing stock from time to time are: (1) saving of feed, (2) preventing the spread of disease, and (3) larger uniformity in the flock. Chickens that remain stunted in growth are incapable of utilising the feed efficiently and as such the longer they are left in the flock the greater the amount of feed wasted. Some diseases spread from the sick to the healthy birds, and the former should be removed from the flock as soon as possible.

Culling for Lack of Vigour. Chickens which are obviously sick and those lacking in vigour should be culled as soon as they are observed. Several symptoms indicate lack of vigour in the growing stock. Young chickens looking dull and tending to huddle in a corner are probably chilled or sick. Droopy feathers

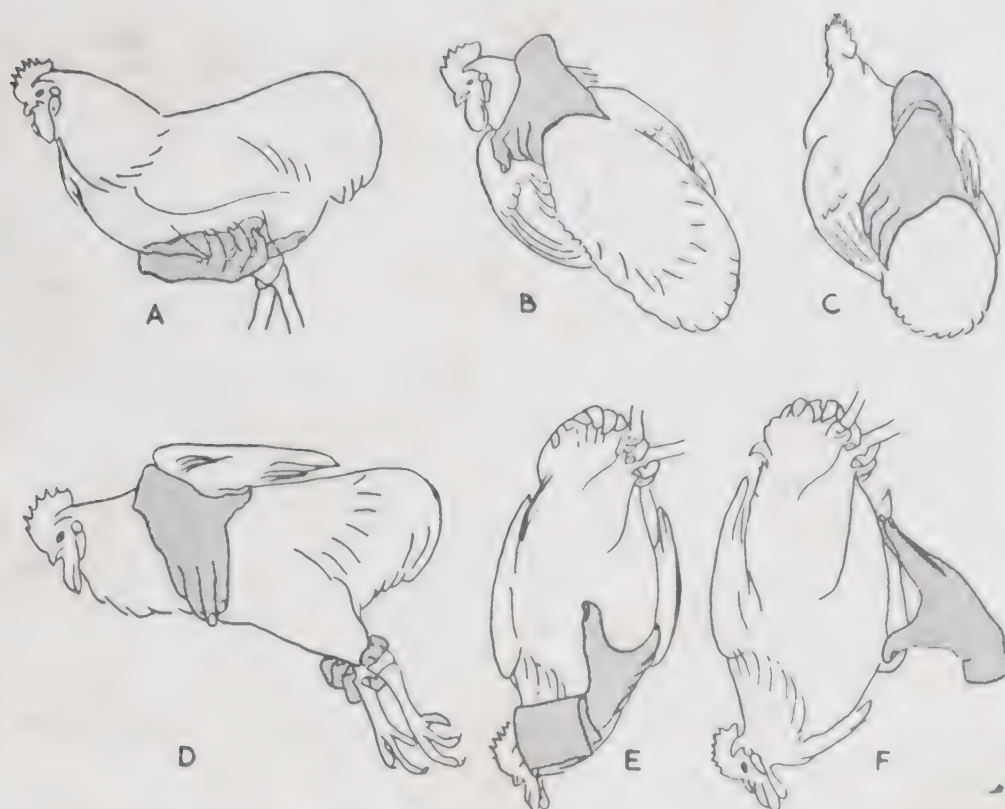


FIG. 28. DIAGRAM SHOWING THE EXAMINATION OF A FOWL FOR BODY CONFORMATION

indicate disease. Plumage when lacking in normal lustre is suggestive of sickness. Dull and sunken eyes usually indicate lack of inherent vigour. Chickens showing gray or pearly eyes should be suspected of harbouring an infectious disease, popularly known as 'fowl paralysis.'

Culling for Poor Feathering. In practically every flock of growing chickens, some birds show poor feathering up to six or eight weeks of age (Fig. 22). This condition may be due to over-crowding or certain deficiencies in the diet, but is generally an inherited character. Poor feathering is sometimes associated with slow growth.

Birds which show a tendency towards poor feathering should not be used for breeding. They should be marked by toe-punching or leg or wing-banding during the first four or five weeks and should be marketed as table birds at 10 or 12 weeks of age.

Culling for Poor Body-shape and Fleshing. The body should be well proportioned, with good length, width, and depth (Figs. 23, 24, 25, 28). The keel should be almost parallel with the back so that the body depth is uniform from front to rear. Long-legged and narrow-bodied birds should be culled and marketed when of appropriate size. Knock-kneed and bow-legged birds, as well as those with crooked breast bones and defective tail carriage (squirrel and wig tails Fig. 29) should be included in the culling list.

Good fleshing on the breast and thighs is particularly important from the point of view of meat production. The degree of fleshing is influenced by the breeding of the stock, the kind of diet fed, the amount of feed consumed, and the methods of management. Overcrowding, internal parasites, and diseases

retard growth and prevent proper fleshing. Poorly developed birds should be culled.



FIG. 29. BIRDS WITH DEFECTIVE TAIL CARRIAGE

Fast-growing cockerels and pullets should be toe-punched or wing or leg banded, so that they may be saved for breeding purposes, when the surplus cockerels are ready for disposal and when the pullets flock is culled at housing time. If cockerels are to be retained for breeding purposes, they may be culled again on the basis of standard requirements outlined in Chapter 2. All the cockerels showing defects and disqualifications should be disposed of for table.

Culling Pullets at Housing Time. It is advisable to put pullets in the laying house about one month before they start laying. The Leghorn pullets may start laying at about 150 days of age, and the general-purpose pullets when about 170 days old. Before they are housed, the pullets should be carefully examined for any defects, so that those that are likely to develop into poor layers during the first laying year may be culled. In order to develop into good layers, pullets must possess an abundance of vigour as indicated by bright prominent eyes, or stout beak on a broad head, bright yellow shanks, lustrous plumage and good fleshing.

CULLING LAYING STOCK

The profits from a laying flock are directly related to egg production. With the increase of egg production in a flock, income increases more rapidly than the cost of maintenance. Since the cost of feed amounts to nearly 60 per cent of the total cost of producing eggs, it is necessary to cull poor layers from the flock as soon as they are detected. Further, by culling poor layers early in the laying season a stop is put to their further multiplication. Birds that have laid well for a short period but stop laying for some reason or other should also be culled.

CULLING NON-LAYERS

With some practice it becomes a simple matter to distinguish a layer from a non-layer. This can be done by closely examining the following parts of the bird:

(a) *Comb*: In a layer, the comb and wattles are warm, fully developed,

bright red and waxy in appearance. In a non-layer they are cold, dull in colour and shrunken.

(b) *Pubic Bones*: When a bird is laying, the pubic bones—the two small bones extending along the sides of the body towards the vent—are spread apart to such an extent that two or three fingers can be placed between them (Fig. 25). After a bird has been laying for some time, the pubic bones become thin and pliable. In a non-layer, the pubic bones are close together and can barely accommodate one finger between them (Fig. 26).

(c) *Vent*: The vent of a laying bird is oval in shape, pliable and moist, while that of a non-layer is small, round, dry and puckered (Figs. 32, 33).

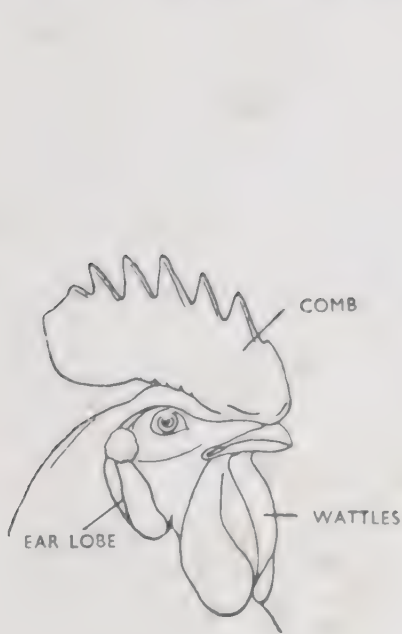


FIG. 30. HEAD OF A MALE WITH NORMAL COMB

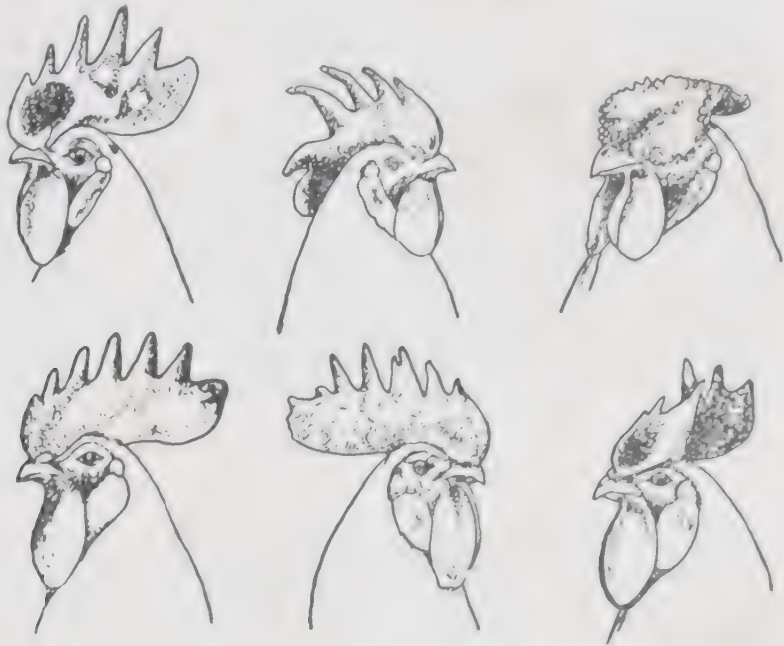


FIG. 31. HEADS OF MALES WITH DEFECTIVE TYPES OF COMB

(d) *Abdomen*: In a layer, the abdomen is soft and somewhat distended to allow for the activity of the digestive and laying organs. The skin covering the abdomen is soft and pliable. Usually three or four fingers are accommodated between the end of the keel and the ends of the pubic bones (Fig. 35). In a non-layer the abdomen is usually constricted, the skin thick and coarse, and the space between the end of the pubic bones and the end of the keel barely able to accommodate two fingers (Fig. 36).

Four important characters which should be considered in distinguishing poor layers from the good ones are: (1) Condition; (2) time and duration of the first annual moult; (3) pigmentation in yellow-flashed breeds and (4) rate of sexual maturity.

Condition. A healthy bird is well fleshed but not fat, the feathering tight, tail and wings carried well up, expression bright and alert, and carriage erect. The bird's head is one of the best indications of its physical condition. Birds with extremely narrow beaks and heads and those with coarse and 'beefy' heads are usually poor layers. Lack of 'condition', and disease are shown by the character

of the comb and the appearance of the eye. A healthy bird has a red comb and wattles, full prominent clear eyes, and a short strong beak. Birds with discoloured, purple, yellow or pale combs, emaciated faces, overhanging long upper beaks, thin breasts, and drooping wings and tails, and also the fat, heavy birds, should be culled as unfit for breeding. Males with defective combs, i.e., lopped, twisted and presenting thumb marks, hollow centre, side spring and uneven serrations, are not fit for breeding and should be culled.

Time and Duration of Moults. It is a natural habit of every hen to shed her old feathers and to grow a new coat annually. This physiological process is termed as moulting. Under normal conditions the average laying bird usually undergoes her first complete annual moult at the conclusion of her first year of laying. The time and duration of the first annual moult are important points in distinguishing the poor from the good layers. Birds that moult early are usually poor layers. The best layers moult late in the autumn at the end of their first laying year, and continue to lay right into the moult period, usually stopping laying to complete their moult in a very short time. Briefly, they are persistent layers and late and rapid moulters. Poor layers, on the other hand, moult in early summer, remain long in moult, and seldom resume laying before the late moulting birds of the flock. Birds that have completed or practically completed their moult by September are classified as early moulters. October and November moulters are 'late' and December moulters 'very late.'

When the selection of layers is made in August or September towards the close of the first laying year, the condition of the plumage provides good evidence as to whether or not the birds are persistent producers. The plumage of the persistent layers shows wear and tear from constant visits to the nest. The early-moulting birds will have growth of new feathers, the webs of which are glossy and bright in contrast to the dry, frayed webs of the old ones. The new quills are large, full and soft, whereas the quills of the old feathers are small, hard and almost transparent. A few pin-feathers in the neck may indicate a short moulting period, but when shedding extends to the body and wings, the moult usually becomes a complete one. A bird usually stops laying when moulting the wing feathers, but may lay while moulting in other parts of the body. However, if the body weight is maintained, exceptionally high-producing hens may continue laying until the wing moult is well advanced.

Pigmentation in Yellow-fleshed Breeds. In all yellow-skinned breeds there is usually an abundance of yellow pigment in the beak, shanks, toes, vent, and eye rings, and in the white of the ear-lobe of the breeds having normally white ear-lobes. The yellow pigment comes from the feed which the birds eat. When the pullets start laying, the yellow pigment of the feed is diverted to the yolk of the eggs instead of its going to the beak, shanks and the other parts mentioned. As long as egg production continues, these parts gradually lose their pigment, so that they become bleached in appearance. The longer the bird continues to lay the greater the degree of bleaching. The yellow pigment does not return to the beak, shanks and other parts until production ceases.

CULLING OF POULTRY



FIG. 32. A GOOD LAYER WITH OVAL, PLIABLE AND MOIST VENT



FIG. 33. A POOR LAYER WITH SMALL, ROUND, DRY AND PUCKERED VENT



FIG. 34. HEAD OF A GOOD LAYER (LEFT) COMPARED WITH THAT OF A BAD ONE (RIGHT)



FIG. 35. A GOOD LAYER WITH ROOMY ABDOMEN --AMPLE SPACE BETWEEN KEEL AND PUBIC BONES



FIG. 36. A POOR LAYER WITH CONSTRICTED ABDOMEN --SPACE BETWEEN KEEL AND PUBIC BONES NARROW

The absence of yellow pigment in yellow-skinned breeds is an indication of the persistency of laying, provided the feeding conditions are satisfactory. Foods which provide rich yellow pigment (xanthophyll), such as yellow maize and greens, produce deeper-coloured skin than those which are deficient in it, e.g., wheat, barley, rice, and milk. The selection of persistent layers on the basis of changes in pigmentation should, therefore, take into account the kind of feed which the laying stock receives.

Table 8. CULLING CHART INDICATING HOW TO TELL A GOOD LAYER FROM A POOR ONE

Character	Good Layer: Keep	Poor Layer: Cull
I. Head	Strongly feminine, fine lean, all parts well-proportioned; square and broad at the top	Has a tendency to be masculine, coarse; may be 'eagle-headed' or 'crow-headed'; narrow and tapering at the top
1. Comb and Wattles	Full, red, waxy, warm and velvety	Dry, hard, shrivelled, cold and coarse
2. Beak	Stocky, well-curved and worn	Very long, thin, and sharp-pointed
3. Eyes	Full, bright, alert and well set	Dull, sleepy, set deep in the sockets, with tendency to be cross-eyed
4. Ear-lobes	Full, waxy and velvety	Shrunken, wrinkled and coarse
II. Neck	Stocky, rather short	Long and thin
III. Body	Capacious	Limited capacity
1. Back	Broad and straight	Narrow, pinched and crooked
2. Sides	Deep, straight	Shallow, barrel-shaped
3. Keel Bone	Long and properly curved	Short and crooked
4. Pelvic Bones	Wide apart, thin and pliable	Close together, thick and stiff
5. Skin	Thin, soft, oily and silky	Thick, dry, rough and leathery
6. Abdomen	Large, soft and free from lumps of fat	Small, hard and with thick fat
7. Vent	Full, large and moist	Small, dry and puckered
8. Feathers	Worn and soiled, moults late	Clean and perfect, moults early
IV. Legs		
1. Shanks	Thin and soft in back	Full, hard and round in the back
2. Toe Nails	Stocky, well-curved and well-worn	Long, thin and sharp-pointed
V. Temperament	Friendly and always happy	Shy, nervous, squawks when caught
VI. Appetite	Hearty eater and crop nearly always full	Mincing appetite, poor eater

The disappearance of the yellow pigment from the bird's body follows always a set order; and those parts of the body which have the most rapid circulation of blood are the first to whiten. The vent is the first part to lose pigment, followed by the eyelid, the ear-lobe, the beak—progressing from base to tip—and the legs, the hard scales at the back of the shank being the last to lose colour. When a bird ceases to lay, the yellow pigment returns to the body in exactly the same order.

Rate of Sexual Maturity. Early maturity and egg production are shown to be correlated, and the bird that matures early makes the best layer. But a bird that starts to lay before she is full grown will not, as a rule, continue to lay throughout the autumn and does not usually lay good-sized eggs. Early sexual maturity together with good body-weight are the two factors that should be looked for while selecting the layers, and culling the undesirable birds.

The culling chart in Table 8 summarises the relationship between certain characteristics and laying condition or laying ability. It will be a useful guide in culling for egg production.

EFFECT OF CULLING ON EGG PRODUCTION

The importance of obtaining the maximum possible number of eggs from a flock in order to make a profit over the cost of production is generally realised. It is natural to assume, therefore, that the greater the amount of culling done throughout the year the fewer would be the total number of eggs produced by the flock, because many birds that are culled would have produced some eggs if they had remained in the flock. But the question is not of getting eggs any how but of obtaining them at a profit. Profits in egg production are determined by taking into consideration the value of the total number of eggs produced by the flock during the year or for a given period in relation to the cost of producing them. It is desirable to have a 'yardstick' to determine whether or not the flock is laying at a profitable level throughout the year. The most practical yardstick is the average number of eggs laid per bird for a given period. Proper culling from time to time helps to maintain the flock at an efficient level of production. Table 9 gives a convenient form in which to record the number of eggs produced each day and the birds that die or are culled.

The average egg production per bird can be calculated in three different ways: (1) average egg production per bird per month; (2) average egg production per bird on a hen-day basis; and (3) average egg production per bird on a hen-housed basis.

Monthly Average. The average egg production per bird per month is obtained by making two calculations. The number of birds at the beginning of the month is added to the number at the end of the month; and the total divided by two gives the average number of birds for the month. The total number of eggs laid during the month is divided by the average number of birds for the month to give the average number of eggs per bird during the month.

Table 9. DAILY EGG PRODUCTION RECORD

Date	October			November			December		
	No. of Females (first of month)			No. of Females (first of month)			No. of Females (first of month)		
	No. of Eggs	Birds		No. of Eggs	Birds		No. of Eggs	Birds	
		Died	Culled		Died	Culled		Died	Culled
1									
2									
3									
4									
Total eggs per month									
Average eggs per bird per month									
Birds culled									
Birds died									

Example: If a flock of 100 birds on April 1, consists of only 90 at the end of the month, the average number of birds for the month would be $\frac{100 + 90}{2} = 95$

If the flock laid 1,800 eggs during the month the average egg production per bird for April would be $\frac{1800}{95} = 18.9$ eggs.

The snag about calculating the average egg production per bird in the above way is that no information can be had regarding the number of birds culled or dead during the month.

Hen-day Average. The average egg production on a ‘hen-day’ basis is obtained by dividing the number of eggs laid during a given period by the average number of birds on hand during the same period. The hen-day average is usually determined on monthly basis.

Example: Let us take a flock with 100 birds on April 1. If all the birds remained in the flock throughout the month there would be 3,000 hen-days involved. If one bird was culled on the fifth of the month, there would be only 2,975 hen-days. If another bird died on the tenth, there would be 2,955 hen-days. If two more birds were culled on the 20th, there would be 2,935 hen-days. If two birds died and three birds were culled on the 25th, there would be 2,910 hen-days involved. This number 2,910 when divided by the total number of 30 days in April will give 97, which represents the average number of birds in the flock in April. If 1,800 eggs are produced by the flock during the month, the average egg production per bird would work out to 18.55.

The same procedure can be followed in determining the percentage of production, and this is a popular way of expressing the level of egg production. If the 100 birds laid 57 eggs on April 1, the percentage of egg production would

be 57. If 96 birds in the flock on the 21st laid 48 eggs, the percentage of production is 50. For the month as a whole, the average number of birds is 97, and $97 \times 30 = 2,910$ hen-days involved, with a total production of 1,800 eggs. The percentage of production for the month is obtained by multiplying 1,800 with 100 and dividing the product by 2,910 (i.e., 62).

Hen-housed Average. The hen-housed average is obtained by dividing the total number of eggs produced during a given period by the number of birds in the flock at the beginning of the period. The hen-housed average for April in the case of flock referred to above would be $1800 \div 100 = 18$ per bird.

The hen-housed average is usually obtained on yearly basis. The total number of eggs laid during the year is divided by the number of birds in the flock at the beginning of the year. This gives the income-potential from a flock better than the other two methods do. The greater the amount of culling necessary and the higher the mortality during the year, the more is the flock handicapped from giving good returns in egg production. On the contrary, the lesser the need for culling from time to time in order to maintain egg production at an efficient level, and the lesser the mortality during the year, the higher the average egg production per bird and the greater the profits would be.

INCUBATION AND HATCHING

MULTIPLICATION of chickens from year to year for renewing the flock or for replacing birds that have died or have been marketed is a very important problem which every poultry keeper has to face. It is a well recognised fact that the flock should be renewed every two years (in exceptional cases at least every three years), if economical production is to be secured. In other words, one-half to one-third of the flock must be replaced each year by new birds, usually chicks. This renewal forms part of a normal programme of successful poultry farming, and does not include the requirements of flock enlargement or of replacement of birds lost through disease, culling or other causes. Hatching of chicks from eggs by incubation is, therefore, necessary to provide for this.

The development of the chick in three weeks from an insignificant spot on the fertilized egg yolk is one of the most remarkable phenomena of nature. The growth of the chick embryo is as complex as that of the mammalian embryo within the mother's womb, with the difference that it takes place outside the mother's body and, as such does not draw its day-to-day food requirements from the maternal blood stream. Nature has devised an ingenious way whereby the hen can deposit her embryo and all the food that it will need to develop and eventually emerge out into independent life. The development of the embryo during the course of incubation is illustrated in Fig 37.

SELECTION OF HATCHING EGGS

In the selection of hatching eggs, strict attention should be paid to several considerations if best results are to be obtained. Infertile eggs and eggs with weak germs add to the cost of hatching, because of the expense of handling and the space occupied in the incubators.

The most important consideration in selecting eggs for hatching is proper parentage. The selection of the parents with respect to their genetic constitution, health and vigour is basic to poultry. Whether the object in view is size, shape, colour, hatchability, or some other desired characteristic in eggs, the chances of attaining it are infinitely better if selection is practised on the breeding stock than if it is confined to any eggs saved for hatching.

Fertile Eggs. A fertile egg may be regarded as a living organism, for it contains the live, though dormant, germ from which the actual chicken develops under favourable conditions. Eggs laid by a mature female fowl not mated by a male bird do not contain the live germ, and cannot, therefore, develop into chickens. These eggs are called infertile or unfertilized eggs.

A fertile egg may be laid within 24 hours after mating. It does not, however, mean that all the females in the breeding pen are mated the very day a male is

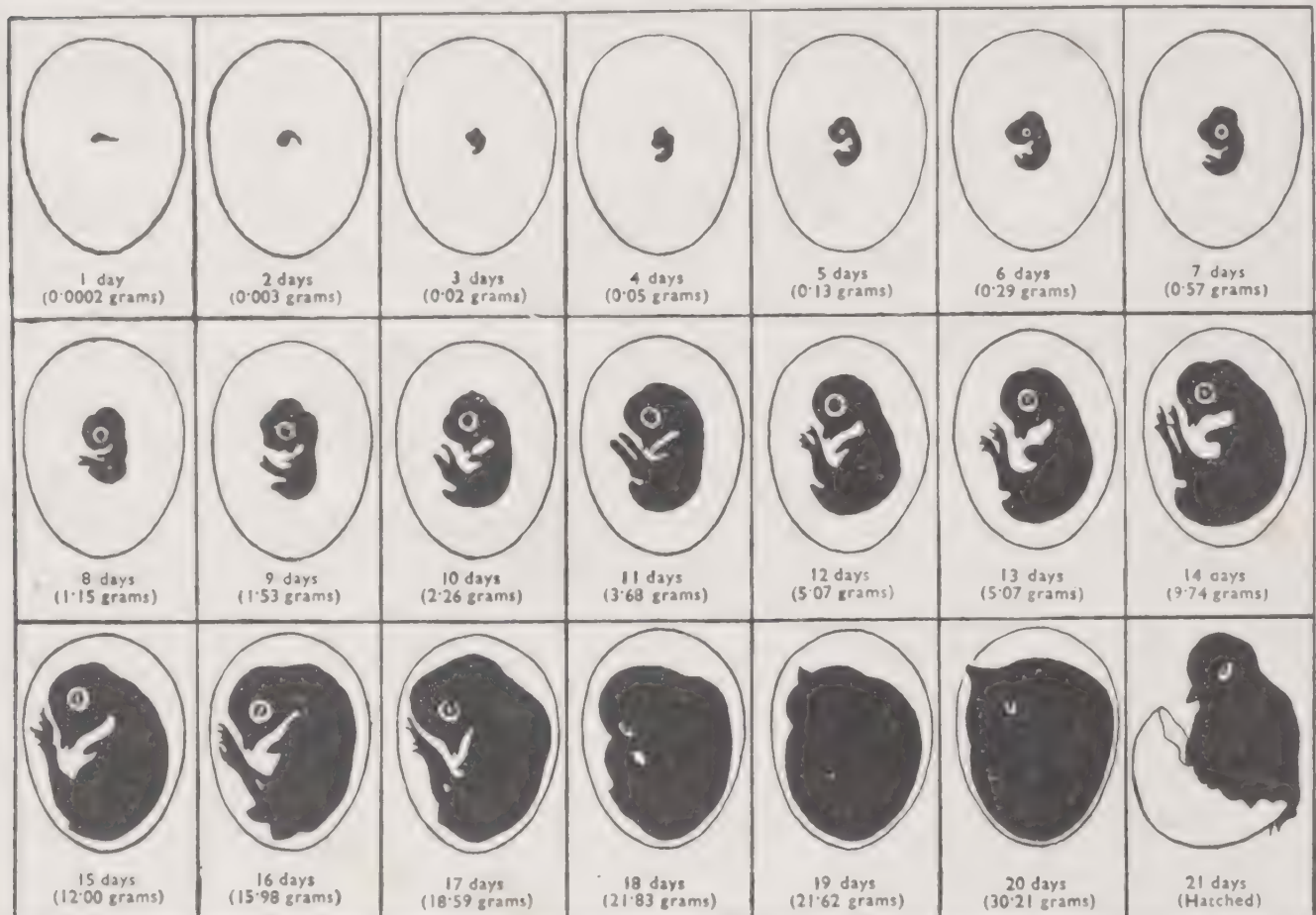


FIG. 37. DEVELOPMENT OF THE CHICK DURING INCUBATION (From Cornell Extension Bulletin No. 205, 1931, U.S.A.)

introduced into the flock. In practice, ten days are allowed to elapse after the introduction of the male, before eggs are saved for hatching purposes.

There are records to show that some birds may continue to give fertile eggs for three weeks after the removal of the male from the flock. This is not generally true and cannot be relied upon, for fertility declines rapidly a week or ten days after the male is removed from the breeding flock.

In pen matings, where poultry is pedigreed, it may be necessary at times to change males during the hatching season, because of poor fertility, disease or death. In such cases it is safe to allow a period of at least 15 to 20 days after the introduction of a second male before the eggs are saved for hatching. Otherwise, the parentage on the male side would be questionable, leading to a mistaken pedigree.

CONDITIONS INFLUENCING FERTILITY

There is no means of recognising fertility or hatchability by merely looking at the egg. It is, therefore, necessary that in order to ensure fertility of a high degree all those conditions which normally contribute to it should be provided.

Fertility is an individual characteristic of both the male and the female, and is not transmitted to the offspring. It is, however, influenced by certain factors, such as nutrition of the breeding flock, disease, age of parents, external characteristics of the egg, rate of egg production in the breeding flock, etc.

Nutrition of Breeding Flock. It is apparent that the survival and successful development of the embryo, deprived as it is of constant replenishment of the food store, must depend on the egg containing the right amount of every nutritional necessity. The fact that the commercial laying hens will produce well on a variety of laying diets should not give rise to the impression that the same diets are adequate for the breeding stock. That the breeding hens can lay eggs even when fed indiscriminately is no guarantee that their eggs would be fertile or would hatch, or that if they hatch the chicks will be able to develop satisfactorily.

Proper breeder's diet should be fed to the birds for a period of at least six to eight weeks before the hatching eggs are required. It is also advisable to give the breeder's diet to the males intended for breeding purpose for at least three months before they are associated with the females. The nutritional factors to which particular attention should be paid in breeder's diets are riboflavin, pantothenic acid, vitamin B₁₂, factors relating to animal proteins such as biotin, and choline, vitamin A and vitamin D, and manganese on the mineral side.

Comparative requirements of breeders and layers as recommended by the National Research Council, Washington, D.C., U.S.A. (Revised in 1950) are given in Table 10.

Vitamin requirements can be met by including about 10 per cent fish meal or other quality animal protein, plenty of greens and 5 per cent dried yeast (unextracted).

Vitamins A and D can be supplied in the form of shark liver oil containing a guaranteed quantity of not less than 600 I.U. of the vitamin A and 85 I.C.U. of vitamin D per gram.

Manganese can be supplied either in the common salt which should form 0.5 per cent of the diet, or in the shell grit *ad lib* by mixing 4 ounces powdered, hydrated manganese sulphate with each 10 lb. salt or grit.

Deficiency of animal protein principally due to deficiency of vitamin B₁₂, leads to rapid decrease in hatchability with progressively poorer survival of chicks that do hatch. Deficiency of riboflavin leads to poor hatchability, with a high incidence of malformed embryos showing oedema and clubbed down. Pantothenic acid deficiency lowers hatchability, and is responsible for a high incidence of embryo mortality, especially during the last two or three days of incubation. Biotin, choline, and manganese are required for normal development of the embryo and the prevention of the condition known as enlarged hock, slipped tendon

Table 10. NUTRITIONAL REQUIREMENTS OF BREEDERS AND LAYERS

Crude Protein (Per cent)			Laying Hens	Breeding Hens
Crude Proteins (per cent)	..	..	15	15
Vitamins				
(a) Vitamin A activity (I.U. per lb.)	..	..	3,300	33,000
(b) Vitamin D (I.C.U. per lb.)	..	..	340	340
(c) Riboflavin (mg. per bird)	..	..	0.9	1.6
(d) Pantothenic acid (mg. per lb.)	..	..	2.5	5.0
(e) Pyridoxine (mg. per lb.)	..	..	1.6	1.6
(f) Biotin (mg. per lb.)	..	..	..	0.07
Minerals				
(a) Calcium (per cent)	..	..	2.25	2.25
(b) Phosphorus (per cent)	..	..	0.75	0.75
(c) Salt (per cent)	..	..	0.5	0.5
(d) Manganese (mg. per lb.)	..	..	..	15

or perosis. Acute deficiency of biotin causes high embryo mortality between the 72nd and the 96th hour of incubation.

Disease-free Stock. The importance of selecting hatching eggs from disease-free stock will be appreciated when it is realised that a number of diseases can be transmitted from one generation to the other through the egg. The most important of the egg-transmitted diseases are B.W.D. (Pullorum disease), fowl typhoid and avian leucosis (fowl paralysis). While selecting eggs for hatching, it must be ensured that the birds from which such eggs are selected are free from these diseases.

Age of Parents. As long as the male bird is vigorous and is himself fertile, his age has little or no effect on the hatchability of the eggs or on the vigour of the chicks from hens mated by him, but generally speaking, the older the cock bird the fewer the hens he can efficiently cover without loss of fertility in the eggs. On the other hand, the age of the female parent influences the hatchability. Hatchability is generally highest in eggs laid by hens in the latter part of their first year and in their second laying season, after which it tends to decline. The decline appears to be a contributory factor in early embryo mortality and also in a large number of failures of the full-term embryos in breaking through the shell.

External Characteristics of Egg. Although much has been said about the relative hatchability of eggs of different sizes, shapes, colours and shell textures, it is generally agreed that the best results are obtained by setting only eggs of medium size, each weighing from $1\frac{3}{4}$ to 2 ounces. These appear to give the best

INCUBATION AND HATCHING



FIG. 38. SPRINKLING INSECTICIDE POWDER
ON NESTING MATERIAL BEFORE SETTING
EGGS FOR NATURAL INCUBATION



FIG. 39. SHALLOW BASKET AS NEST FOR
NATURAL INCUBATION OF EGGS

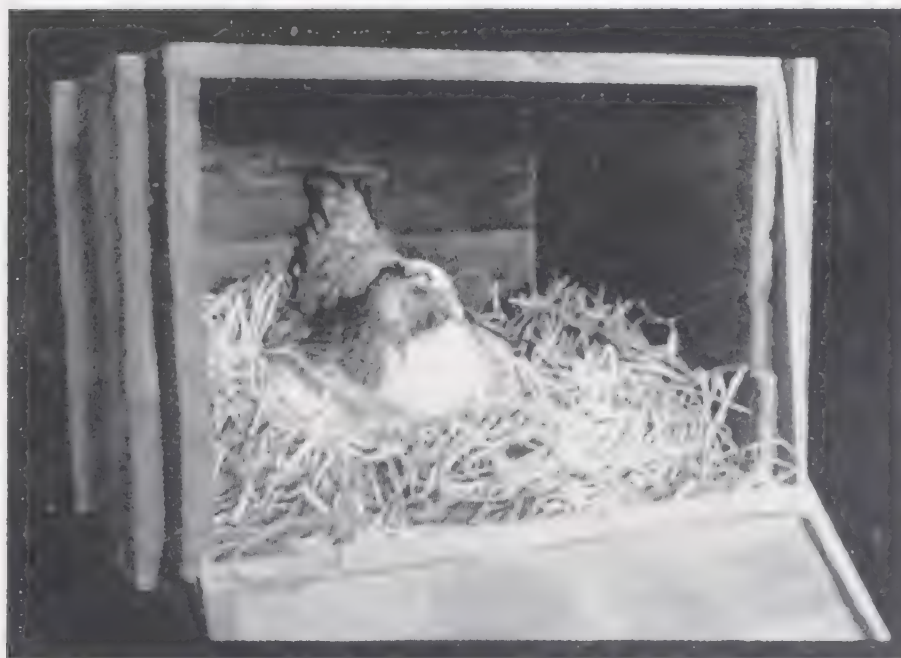


FIG. 40. PACKING CASE AS NEST FOR NATURAL INCUBATION



FIG. 41. CARE OF HEN AND CHICKS AFTER HATCHING

class of chicks as well as optimum hatchability. The shape of the egg is only of importance in that it is a hereditary characteristic and the continued use of badly shaped eggs will only tend to perpetuate and increase this defect, which is undesirable in the commercial table egg production. Eggs selected for hatching should be uniform in size, shape, weight and colour.

The texture of the shell is important in determining the rate of loss of moisture during the periods of preservation and incubation of hatching eggs and also during the storage of eggs for consumption. As shell texture is also largely an inherited characteristic, the use of eggs with good texture is desirable for hatching. Any crack in the shell, however small, disqualifies the egg for hatching. Such eggs should be rejected.

Egg Production in Breeding Flock. It has been shown that when the egg production of the hens is at a high level, the fertility and hatchability of the eggs are also high, provided the fecundity of the individual birds, both male and female, has been proved. These characteristics tend to decrease as the rate of production declines.

Besides, the fertility and hatchability of eggs are also influenced by seasonal conditions (during certain seasons of the year, such as very early spring and hot summer, they are low), number of cocks to the hens in the flock, physical condition of the breeders, and storage conditions before incubation.

PRE-DETERMINING FERTILITY

The obvious advantage of being able to know, before setting the eggs as to which eggs are fertile, and what sex would develop in each, is so great that it has led to a number of so-called sure tests being mooted. However, none of these has any real scientific basis.

One test for pre-determining the fertility of eggs which probably has the widest popular acceptance, is the specific gravity test. It is claimed that fertile eggs have a relatively higher specific gravity than infertile ones. But the claim has not been substantiated. As a matter of fact, difference is generally found in the specific gravity of eggs laid by different hens, no matter whether the hens have been mated or not.

As regard determining the sex of an egg by external appearance, the belief which is probably the most popular is that the shape of the shell provides a clear indication. This too has no factual support; and it has long been established that the long narrow eggs, sometimes credited with hatching only males, and the short round oval eggs supposed to produce a preponderance of females, yield almost equal number of birds of both sexes. The position of the air-cell during incubation, for which a similar claim is sometimes made, is equally unreliable as a test.

HANDLING AND CARE OF HATCHING EGGS

Cleanliness is of first importance in keeping down the spread of disease. Dirty eggs harbour disease germs, which will thrive and multiply under the ideal conditions provided by the incubator.

Proper Nesting Facilities. In order to produce eggs as clean as possible, the hens should have ample nest accommodation, preferably at least one nest box for five hens—or one for even three or four hens if trap-nesting is adopted. The nest boxes should have plenty of good clean dry straw or other bedding material, which should be changed when necessary to ensure regular cleanliness.

Collection and Storage of Eggs. Eggs should be gathered from the laying boxes as frequently as possible, and especially during the summer months even hourly collection cannot be said to be too much. The intervals may be prolonged during the cold months, and eggs collected thrice or four times daily. Unless the eggs are very badly soiled, they should not be washed; ordinary stains can be removed by rubbing with a coarse, dry or moist cloth. The eggs should be stored, preferably in clean cases, in a location that is dry, well-ventilated, and free from strong odours, and where the temperature is maintained at a fairly uniform range of 50° to 60° F. Since the germ activity commences at 68° F., it is important that the temperature should be kept below this point, and the sooner the internal temperature of the egg is brought below the critical temperature of 80° F. and embryonic development arrested the better. If not, the growth of the embryo may proceed too far and lower hatchability or give rise to weak chicks.

Eggs should be set for hatching within ten days after they are collected, in order to ensure maximum hatchability. It is also desirable to turn hatching eggs once or twice daily to avoid any risk of the germinal disc adhering to the inner shell membrane. Shaking or rough handling of eggs should be avoided, as this may cause the rupture of the membranes or minute cracks in the shell.

Transport of Hatching Eggs. In any extension programme of poultry development it is at times necessary to distribute hatching eggs from a central multiplication farm, although it is not a very ideal method of multiplying poultry because of the heavy losses entailed. Eggs may have to be transported over long distances, and unless special care is taken in packing and during transit the results are likely to be disappointing, especially when the eggs are carried on bicycles, bus-tops or in bullock carts. Even air transport of hatching eggs seems to lower hatchability because of the vibrations, and fluctuations in the temperature and atmospheric pressure during the flight.

As regards packing the hatching eggs for long-distance transport, the several specialised packing cases which are commonly used in the West have not yet found a place in this country because of the cost involved and the relatively small number of eggs handled.

Experience has, however, shown that hatching eggs could be transported over considerable distances in this country economically by wrapping each separately in hay or paddy straw and then packing these in a bamboo basket. Such packing provides for necessary ventilation and ensures protection against breakage. In the distribution of hatching eggs so packed, in one of the States only three out of nearly 11,000 were reported to have suffered damage in transport, involving railways, jeeps, public buses, bullock carts and bicycles. The percentage of hatchability varied from 15 to 85.

Number of Eggs to Set. In producing birds to increase the egg-producing flock, the number of pullets desired will largely govern the number of eggs to set. It is a common experience that (a) approximately one-half of the chicks hatched are pullets, (b) on the average, only 50 to 65 per cent of the eggs set actually hatch, and (c) disease, accidents and culling will reduce the number of pullets which are suitable to be kept on as a part of the producing flock. It is, therefore, advisable to set five or six eggs for each good pullet desired. The number varies with the degree of fertility and with the skill and management of the personnel.

METHODS OF SECURING CHICKS

Chicks required for starting new poultry enterprises and for extending or replacing the existing flocks can be secured in three different ways: (1) hatching with hens or by natural incubation, (2) hatching with machines (incubators) or by artificial incubation, and (3) buying day-old chicks from other hatcheries. The practice of getting eggs hatched by a hatchery or by another poultry man equipped to take care of a larger number of eggs is called custom hatching. Such a plan secures for the poultry man supplies of birds of known breeding without the expense involved in maintaining independent incubating equipment. Custom hatcheries are popular in all countries where poultry husbandry is well advanced, but they are yet to be introduced in India.

NATURAL INCUBATION OR HATCHING

Natural hatching under a broody hen is suited best to the needs of the small poultry keeper who wants to raise a few chicks without bother and expense of owning and managing an incubator. This has, however, one inherent disadvantage in that it is not always possible to get hold of a broody hen just when she is wanted.

Natural hatching will, probably, continue to be the most popular method of incubation not only under the village conditions in the country but by and large also for all enterprises consisting of only a few hens. The Indian *desi* hen is an ideal sitter and mother. Four or five *desi* hens can easily take the place of a fifty-egg incubator and not only hatch out the chicks but also take care of them as well. These natural incubators are a less expensive investment than a machine, cost less to operate, and require less attention. Difficulties are to be expected, however, particularly in getting the required number of broody hens at the proper time.

When the natural method of incubation is emphasized, it is advisable to select the hens carefully. Only hens in good health and of quiet disposition should be used. Hens are generally to be preferred to pullets.

Nests. The nests for setting hens should be placed in a quiet and comfortable place away from the laying hens and should be protected from wind, rain and predatory animals. The nests should be shallow and roomy to prevent the hens from breaking the eggs, when leaving or returning to them. Anything like a shallow

round basket, half-cut mud pot, a packing case, etc., would serve as nest (Figs. 39, 40). It is best to have the nest on the ground or put moist earth under the nesting material for moisture to prevent too rapid drying out of eggs. Wood shavings or fresh clean hay chaff make the best nest material and should be so arranged as to slope gradually towards the centre to a depth of about three inches. This prevents eggs from rolling out, while allowing them to spread apart when the hen steps into the nest. A small quantity of wood ash mixed with three or four times its bulk of a good insecticide like DDT or Gammexane sprinkled into the nesting material helps to keep away parasites, ants and other vermin (Fig. 38).

Signs of Broodiness in a Hen. When a hen goes broody, she usually clucks, ruffles her feathers and remains sitting when approached. She generally seeks dark corners or nests, which she prefers to her companions outside. This is a sure indication that she is ready to set.

Preparing and Setting Hen. Setting the hen should be done preferably in the evenings so that she may be accustomed to her new location in the night. It is wise to try her for a day or two on two or three ordinary eggs which are not to be hatched. If she is inclined to set without much fuss or excitement, eggs to be hatched may be placed under her. The number of eggs to be placed depends on the size of the broody hen and the eggs themselves. It is important to remember that before the hen is placed in the nest for natural incubation she should be treated for lice which she generally harbours. This is done best by dusting her with sodium fluoride powder thoroughly.

Care of Broody Hen. Although the broody hen requires very little care, some attention should be given to her regularly. For the first one or two days it is advisable to confine the hen to the nest, except for two periods during the day—when she may be released for feed, water and exercise, and when it is necessary for her to come out to stretch her legs and to empty her bowels without fouling the nest and the eggs. It is a good plan to combine these needs during set periods. The hen is very much a creature of habit, and she will soon come to associate her daily freedom with a fixed time and will show signs of restlessness as the hour approaches. It becomes important to see that she gets her food and exercise at the same time of the day. She should be allowed to go back to her nest after about 20 minutes, the interval being less in very cold weather. These periodic exits also help to aerate the eggs.

Most of the broody hens come out of their nests of their free will, but some may have to be lifted off the eggs. While doing so, certain amount of care is necessary to see that no eggs are lifted along with the hen. The wings should, therefore, be lifted first to release any eggs that may be lightly held between the wings and body. When it is certain that no eggs are held between the body and wings, the hen may be picked up with one hand holding her under the body round the legs, and the other hand stretched over her back. The hen should always be lifted from and returned to the nest head first to reduce her resistance and to prevent the wings getting caught up by the sides of the nest.

Testing Eggs. It is advisable to test the eggs between the 7th and the 9th

day of setting, and to remove any clear (infertile) eggs. If possible eggs should also be re-tested on the 15th or 16th day and all those dead-in-shell removed. From the 18th day the hen should not be disturbed, but the nest may be kept open so as to let her have access to feed and water. Chicks normally begin to break through the shells on the 20th day, and it is important that the hen does not desert the eggs until all the chicks are out of the shells, for some hens will start to mother the first few chicks and ignore the remaining unhatched eggs. The hatch is usually complete on the 21st day.

As soon as the hatch is completed, all shells, unhatched eggs and nesting materials should be removed, fresh litter put in, and the nest given another dusting with insecticide. The hen and the chicks should be left alone for at least two days, during which the latter do not require any feeding.

ARTIFICIAL INCUBATION

Incubation of eggs by methods other than the one described above has been practised since the days of early Chinese and Egyptian civilizations dating back to 1,000 years B.C. The early Chinese are said to have had two systems of hatching. Under the one, the eggs were placed on the top of a heap of rotting manure and lightly covered with litter so that the heat of fermentation, which was enough to give satisfactory hatches, was utilized. In the other method, a charcoal fire was lit in a tall cylindrical oven made of fire-clay or earthen materials and having a combined stoke hole and portable damper at the base. An inverted cone of fire-clay partially filled with ashes was fitted on the top of the oven. In the inverted cone resting on the ashes was the egg basket, which in turn was covered with a flat cone of straw resembling a sun-hat. The egg basket had apparently several layers of eggs.

Modified Form of Chinese Incubator. A modified form of Chinese incubator as described below is still in use in China, the Philippines, Singapore and other South-East Asian countries, and about 50 per cent of the chicks reared in these countries are said to be hatched with such incubators. The operators are mostly Chinese who have become adept and operate large hatcheries.

The incubator consists of a rectangular wooden box, open at the top and measuring about 18 feet long, 6 feet broad, and $2\frac{1}{2}$ feet deep, and containing 20 baskets, each $2\frac{1}{4}$ feet deep and $1\frac{1}{2}$ feet in diameter. The space below, between and around the basket is packed with paddy husk or sawdust. Eggs for hatching are warmed by exposing to the sun or over a fire, wrapped in open sacking and arranged in layers in each of the baskets. There are eight such layers, each layer containing 100 eggs in each basket. The top of the box is covered with gunny sacks, and eggs are turned four times a day by rotating them in an open flat basket. It is necessary that rooms where these incubators are installed should be absolutely draught-free. The heat in the incubator is produced by the metabolism of the growing chick-embryo, and the temperature of the eggs is tested before they are turned, by placing them against the upper eye-lid or the side of the nose. Eggs are 'candled' on the fourth and again on the 14th day of incubation by either placing

them against a hole in the wall through which a beam of sunlight enters the room or by holding them against a candle light.

On the 15th day of incubation the eggs are transferred from the incubator to the 'hatching bed,' consisting of a large wooden tray in which they are arranged in single layers and covered with warm blankets. Eggs in the 'hatching bed' are turned four times a day until hatched. It is claimed that from 75 per cent to 80 per cent of fertile eggs are hatched successfully by this method.

An incubator of the size described above takes 16,000 eggs and is said to cost approximately Rs. 400 to make.

The ancient Egyptians are said to have used artificial incubation on a large scale and some of their 'incubators' were able to hold up to 90,000 eggs. These structures were built of mud bricks and contained a central corridor, sufficiently high to permit men to walk about. Light and ventilation were provided by having holes in the roof. On either side of this corridor and communicating direct with it, was a series of egg ovens of a standard pattern. The egg chamber was at ground level and had an opening into the corridor through which the attendant could crawl to attend to the eggs or chicks. Above the egg chamber was the heating compartment, in which dry camel dung was burnt in an open circular trough with a central hole in the floor. Until the beginning of the last war (1939-45) several of these ancient-type incubators were still in use in Egypt, and were giving hatches of nearly 70 per cent of the fertile eggs, which can be taken as a testimony to their efficiency.

In all such methods of incubation there must have been more art than science, and success or failure must have depended entirely on human skill. This personal factor of the skill has been almost eliminated in the cabinet incubator, which has come into common use in advanced countries.

Modern Mechanical Incubation. The comparatively modern methods of mechanical incubation had their origin about 200 years ago in the successful hatching of eggs by the French Physicist Reaumur in a specially designed box in which the temperature was mechanically controlled. In course of time the Americans and the English designed several types of incubators.

Advantages of Artificial Hatching. Machine or artificial hatching has many advantages, such as (1) a large number of chicks may be hatched at one time, (2) chicks may be hatched at any time during the year, which is of importance in securing early-hatched chicks, (3) chicks may be hatched practically free of diseases and parasites (there being no way in which disease and parasites can gain access to the baby chicks, except those diseases which may be present within the shell) if the incubator and eggs are properly disinfected, (4) there is more certainty regarding the hatch when good incubators are properly operated than when hens are relied upon, and (5) the use of incubators is economical in the long run, especially in large-scale hatching.

Principles of Incubation. Artificial incubation is merely an attempt to copy and, if possible, to improve upon the operations of the hen in hatching eggs. The essentials of successful incubation are correct temperature, ventilation and moisture.

Types of Incubators. There are two general types of incubators, the flat-type and the cabinet-type. Each of these is again divided into hot-air and hot-water types. The hot-air machines depend for their working on currents of hot-air generated directly by the source of heat. In hot-water machines, the air surrounding the eggs is heated by the circulation of heated water. Each type, if properly made, is good. The hot-air machine is usually less expensive and is, therefore, less subject to depreciation. There is also no danger of water containers becoming leaky during a hatch. Regulation of temperature is accomplished more rapidly with the hot-air machine than with the hot-water one. The hot-water machine has, however, one great advantage in that it can retain the heat for a longer period of time, which is of definite value when heat-supply fails for a short time, which may happen especially when the machine works with electricity.

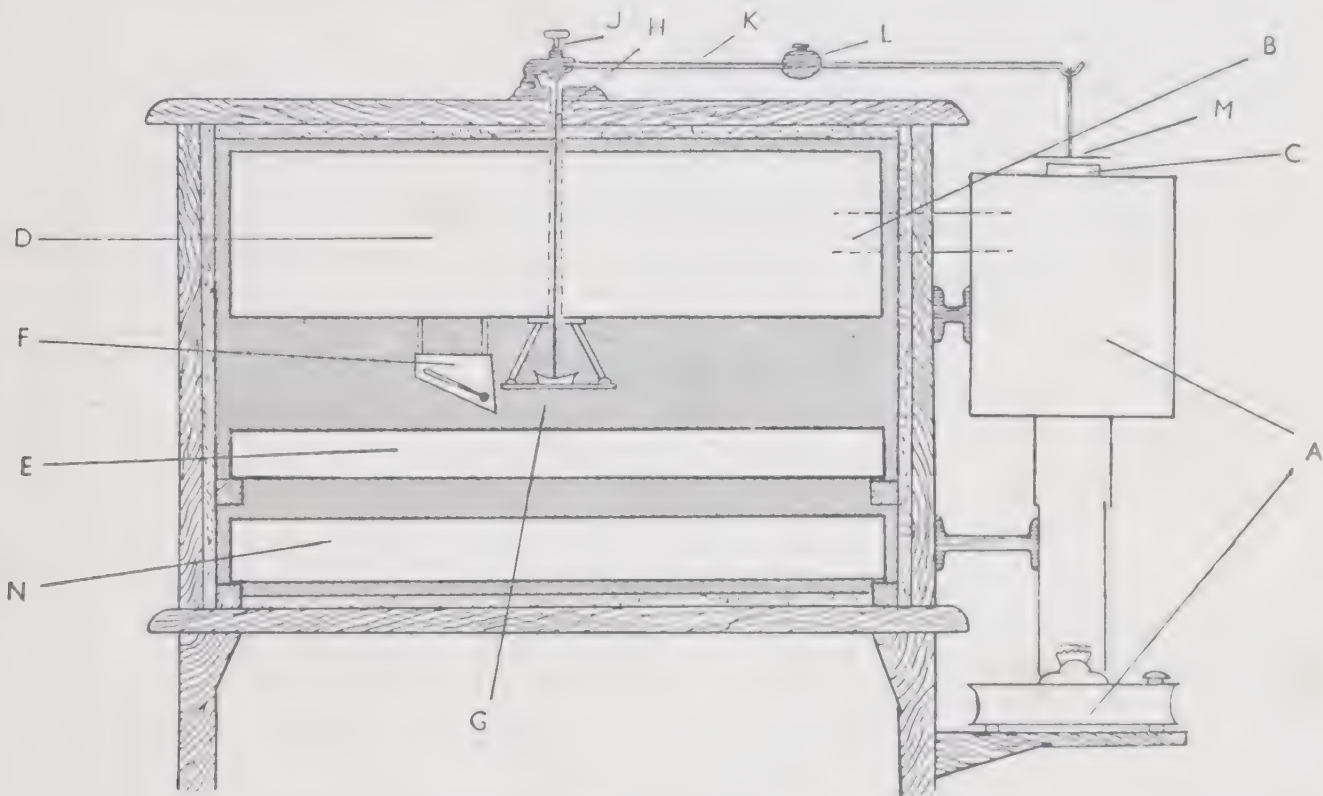


FIG. 42. TYPICAL FLAT-TYPE INCUBATOR HEATED BY OIL LAMP (From Bulletin No. 148, Min. of Agri. and Fisheries, U.K., 1954)

Flat-type Incubators: The flat-type incubator is usually of small capacity, ranging from 50 to 500 eggs, with only single-layer incubation, the eggs lying flat. These incubators are heated from outside and the heating of the eggs inside is done from above, ventilation being effected by the changes of internal temperature. In the hot-air type of incubator (Fig. 44) fresh air enters warmed by the hot-air tubes at the top of the machine, and as it cools, sinks towards the floor and escapes by the vents or openings at lower levels. In the hot-water type the air enters at a low level and escapes, after it has been warmed, through vents at upper levels.

Fig. 42 illustrates a typical flat-type of incubator, heated by oil lamp. The oil heater (A) has two outlets for its heat, one (B) sending the hot air into the heating chamber (D) which may be occupied by air or filled with water depending

on whether it is a hot-air or hot-water type of incubator. The other outlet (C) is an exhaust flue which allows unwanted heat to escape to outside air without influencing the internal temperature. The heating chamber (D) is warmed by the hot-air from the heater and in turn heats the eggs in the egg tray (E) by downward diffusion. Suspended above the egg tray are the thermometer (F) and the capsule holder (G), which is a rigid structure which firmly supports the capsule or thermostatic contrivance for regulating the temperature. A metal rod (H) rests vertically on the top of the capsule and passes upwards through a hollow tube to make contact with the specially shaped base of a set-screw (J) incorporated in a hinged arm (K). This arm carries an adjustable weight (L), which can slide along the arm until it exerts the right amount of pressure to make the arm work freely but not too easily. Its remote end carries a hook, from which is suspended a damper (M), which at rest fits snugly and squarely on the top of the exhaust flue (C).

The heat regulating principle in these incubators is simple. When the temperature of the incubator rises above the level to which it is previously adjusted the capsule which is made of two thin metal sheets welded together and containing a small amount of ether or some other volatile fluid which will cause it to expand or contract in thickness as the temperature rises or falls, expands and forces the rod (H) upwards, and this in turn pushes the hinged bar and lifts the damper off the exhaust flue. If the incubator temperature is correct the damper hangs just free over the flue, but as soon as it falls below the required point, the damper closes down and all the heat goes into the incubator. Although this arrangement is simple, particular care is necessary in the assembly of the incubator if 100 per cent result is aimed. The incubator must stand absolutely level, and the hinged bar should be carefully fixed so that the damper will squarely cover and sit flush on the flue when in the closed position.

The thermometer must be so adjusted that the centre of the bulb is at a height above the egg tray recommended by the makers. Any deviation from this position will result in incorrect heating of the eggs, because in these incubators the whole of the inside air is not at the same temperature as is the case with the cabinet-type machine.

In some types of flat incubators the chicks remain in the egg tray after they hatch, but others have a nursery or chick tray (N) below the egg tray. If there is no chick tray it may be necessary to darken the inspection window to prevent the hatched chicks struggling to get to the light over the others that are still trying to get out of the eggs. In machines with a separate chick tray either some space is already provided in front of the egg tray, or provision is made of a removable strip of wire mesh in front of it which can be removed after about a third of the chicks have broken their shells. The chicks moving towards the light fall gently on to the soft material at the bottom of the chick tray. In machines where space already exists between the front of the egg tray and the incubator wall, chicks automatically drop into the chick tray as they are hatched.

The heater (A) may be operated by oil, gas or electricity, so that this type



FIG. 43. HOT-WATER FLAT INCUBATOR HEATED BY OIL LAMP



FIG. 44. HOT-AIR FLAT INCUBATOR HEATED BY OIL LAMP WITH CLOSED AND OPEN DOORS



FIG. 45. SINGLE-ROW CABINET INCUBATOR
HEATED BY OIL LAMP OR ELECTRICITY



FIG. 46. DOUBLE-ROW CABINET INCUBATOR
HEATED BY ELECTRICITY

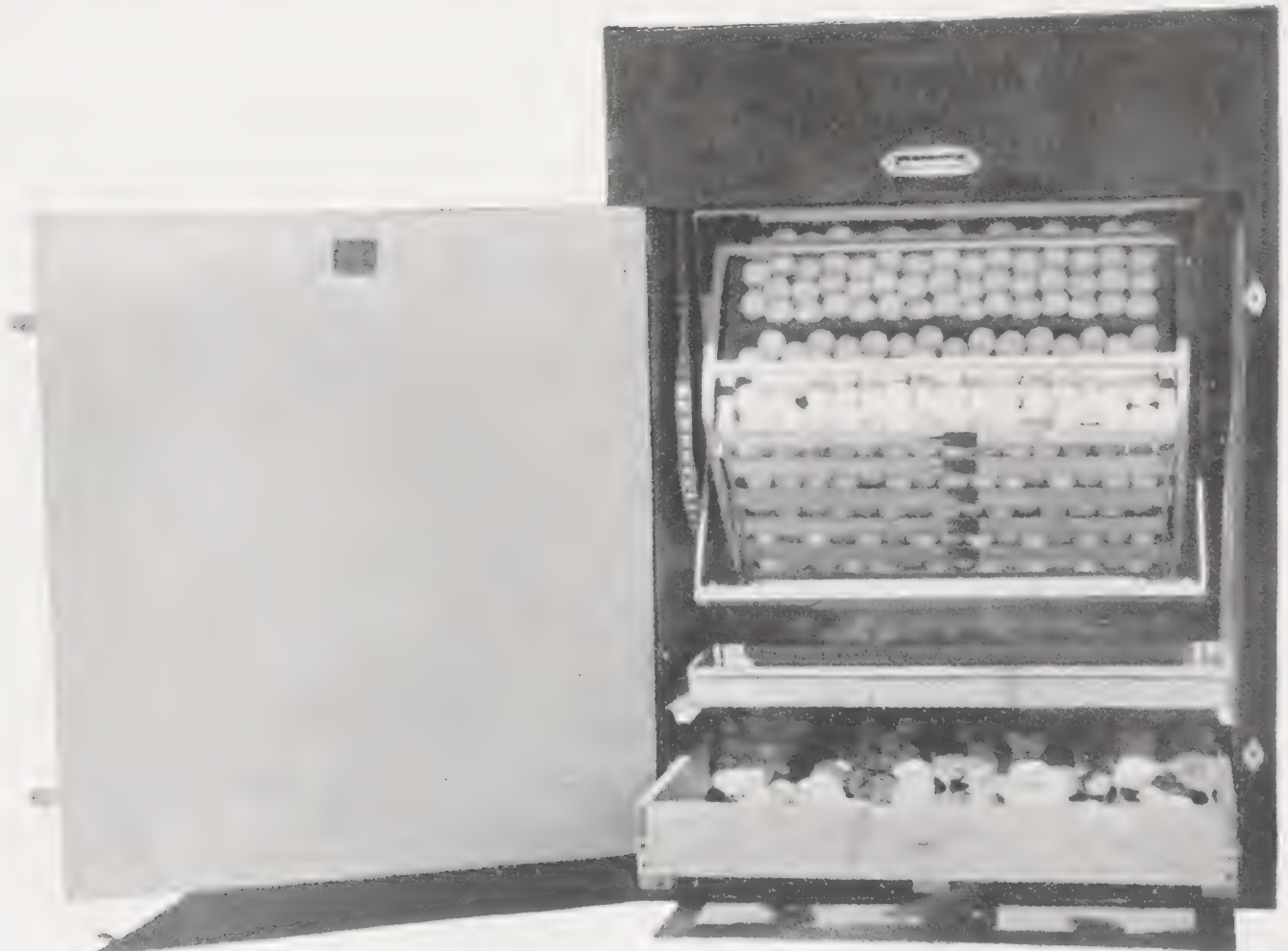


FIG. 47. CABINET INCUBATOR WITH AUTOMATIC REVOLVING TRAYS

of machine can be used almost anywhere. In most flat-type incubators the eggs are turned by hand. It is important that the eggs should be turned in opposite directions each time.

Cabinet-type Incubator: By far the greatest advances in incubation have been made in the cabinet-type of machines (Figs. 45 to 47). The chief difference between these machines and the flat-type are (a) the eggs are placed in the upright position with the broad end upper-most, (b) the eggs are turned by tilting the trays through 80 to 90 degrees, *i.e.* 40 to 45 degrees each side of the horizontal, and (c) the ventilation and internal air circulation are mechanically controlled by some arrangement of fans or stirrers.

One of the greatest advantages of the cabinet type incubators is the saving in floor space which it permits. For example, a modern cabinet incubator designed to hold about 12,000 eggs and electrically operated requires a floor space of 12' $\times$ 6' and can be operated in a room 16' $\times$ 13'. This saving in space is effected mainly by the arrangement of the egg trays in stacks and the mechanically operated ventilation.

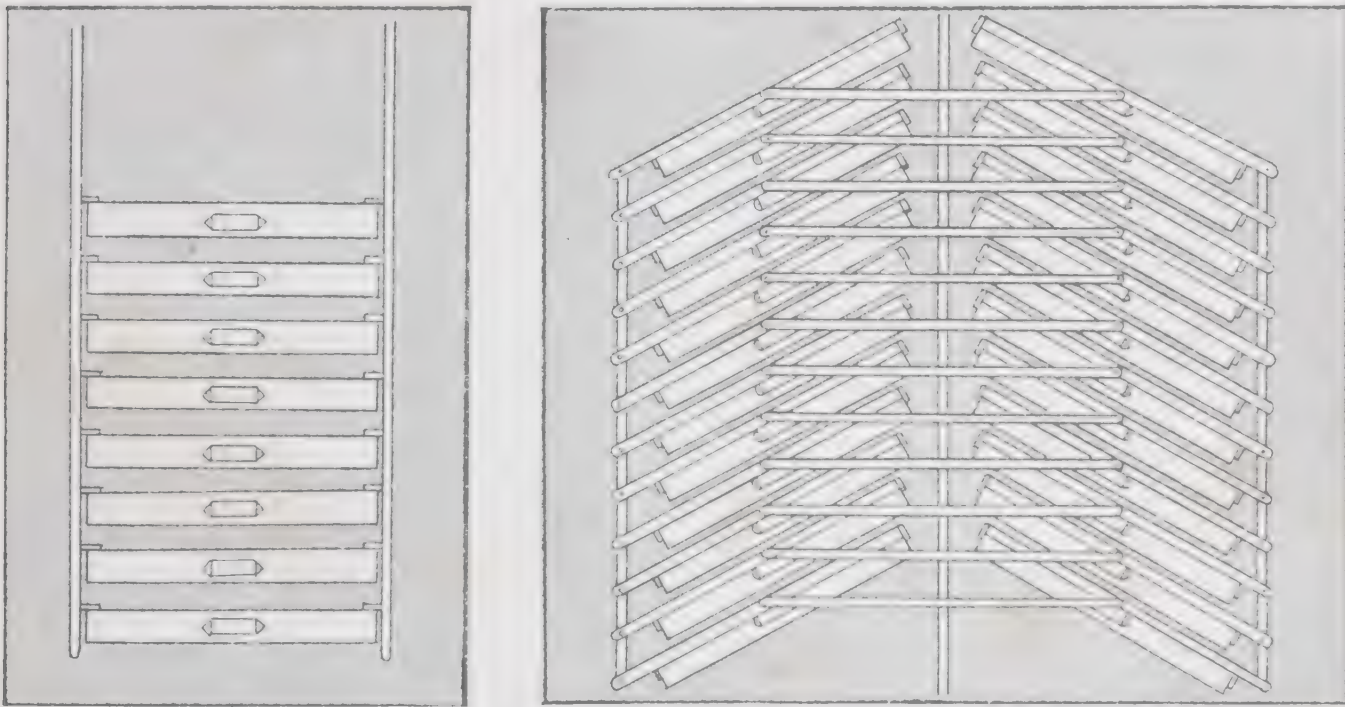


FIG. 48. LAYOUT OF EGG-SETTING TRAYS IN CABINET INCUBATOR: (a) SINGLE-ROW AND (b) DOUBLE-ROW

Figure 48 represents a typical layout of the trays in a cabinet incubator, which in the most recent types, has separate setting and hatching compartments. The larger of these two is the setting compartment. Only one-third of the trays are loaded each week, and these are distributed evenly throughout the incubator racks. Each loading is given a distinctive coloured label for easy removal to the hatching compartments. Red, white and blue are the usual colours, and these will appear in sequence from top to bottom of each rack.

There is no need to turn the eggs in the hatching compartment. The hatching trays are usually slightly larger than the corresponding egg trays in every dimension, so that the eggs remaining after the last candling on the 18th day can be easily transferred to the hatching tray by a simple process of inverting the hatching tray over the egg tray and then turning the combined trays upside down and removing the egg tray. Naturally this manipulation has to be done gently and carefully to avoid any damage to the embryos.

The heating medium inside the incubator may be either electricity or water heated by electricity, oil, coal or gas. In the all-electric incubators the same current that provides the heating also takes care of the ventilation fans—or other means of stirring the air—as well as the automatic turning device, if one is incorporated. With the other forms of heating a separate motor is required for the fans, etc. The all-electric incubator has added advantages of compactness and freedom from complicated external fittings with resultant economy of floor space required for operation. The incubator is, however, more vulnerable to failure on account of risks of break-down of power supply.

Temperature regulation is effected by means of cut-in-cut-out switches in the case of all-electric incubators, and by some capsule and damper arrangement in machines having any other form of heating system.

Ventilation is provided by means of vents arranged in such a way that the air drawn into the incubator passes over the heaters and acquires the desired temperature by the time it reaches the eggs. The air stirrers—whether fans or paddles—ensure freedom from air pockets in which the local concentration of carbon dioxide can attain dangerous levels. The overall design of the fans and air ducts is the key to efficient circulation of air throughout the incubator, and is probably one of the most important single factors in determining the efficiency of the incubator.

Moisture is usually provided from flat trays which have large evaporating surfaces, or by some system of water injection arranged in conjunction with the ventilation circuit.

Turning may be manual by means of an external handle that saves the opening of the incubator frequently, or automatic by means of a mechanical device that can be set to turn the whole of the contents of the incubator at regular intervals.

Whatever the type of incubator chosen, it should possess the following qualities:

1. The incubator should be efficient, which means that it should be capable of producing a good hatch without undue attention on the part of the operator. This calls for proper control of temperature, ventilation and moisture.
2. It should be durable and able to stand ordinary wear and tear so that it may not depreciate rapidly.
3. It should be simple to operate—the thermostat should be accurate, sensitive and easy to regulate.
4. The fittings such as the lamp, trays, doors, thermometers, etc. should be conveniently arranged and be of dependable quality.

5. It should be well insulated against fire and electricity, and should be able to conserve heat.

The most suitable location for an incubator is the one which ensures proper conditions of temperature, ventilation and moisture. Even well insulated incubators are influenced by their location. An ideal room for an incubator is well insulated, convenient-sized, easy to maintain at a steady temperature of 60° F. properly ventilated without drafts, and well lighted. The incubation room should be readily accessible, as the machine has to be visited several times daily during the hatching season. Its construction should be such as to ensure safety against risks from fire, and it should be large enough to allow handling of eggs and the machine conveniently. Enough number of tables and shelves should be provided in the room to facilitate work.

PREPARING INCUBATOR FOR THE SEASON

The incubator provides highly favourable conditions for the growth and multiplication of the bacteria responsible for many poultry diseases. Except in the case of a new machine, not used before, every incubator needs the most meticulous hygienic check-up at all stages of its operation, and the application of all methods of disease control compatible with economic working.

All eggs and chick trays and other detachable fittings of the incubator should be washed thoroughly with a warm solution of 4 per cent washing soda, made by dissolving a double handful (both hands cupped together) of washing soda in 2½ gallons of water. This will soften grease and allow the fittings to be thoroughly cleaned. All other equipment used for the transport of eggs or chicks should also be treated in this way at regular intervals.

The inside of the incubator, especially the hatching compartment, must also be kept free from dust and dirt. The hatching compartment should preferably be fumigated after removing the trays, etc. and then either cleaned with a vacuum cleaner to remove all the fluff, or sprayed with a solution of strong disinfectant to lay the fluff, and finally washed with washing soda solution.

A good disinfectant can be made by adding one part by volume of a solution of sodium hypochlorite, guaranteed to contain between 1 and 2 per cent of free chlorine, to 19 parts of water. Such a solution does not keep its strength long, and needs to be made afresh from the stock solution as and when required.

Fumigation. The main object of fumigating the incubator is to destroy bacteria inside the machine, to reduce infection in the newly hatched chicks, and to prevent its spread to the rest of the hatchery premises. Notwithstanding its general unpleasantness, formaldehyde gas remains the most economical and most efficient fumigant for this purpose.

Fumigation with formaldehyde gas is achieved through the interaction of two simple substances, viz., formalin (which is a 40 per cent solution of formaldehyde gas in water), and potassium permanganate crystals. Both these substances can be obtained readily from the chemist and can be kept safely in bulk on the farm premises. Formalin should be bought in glass-stoppered bottles and stored

in a cool place well away from strong light, a cupboard being advisable. Potassium permanganate should also be preserved in a wide-mouthed stoppered bottle, preferably of dark tinted glass, and should be kept in a cupboard.

When these two substances are mixed there is a violent reaction and formaldehyde gas is liberated in dense clouds. Care is necessary to ensure that there is no injury to the operator, either through being splashed with the reacting materials or from inhaling the fumes in high concentration. The amount of formalin and permanganate to be used depends on the capacity of the incubator and the desired strength of fumigation. For ordinary routine fumigation the following quantities are required per 100 cubic feet of incubator capacity:

Formalin	..	..	..	1½ fluid ounces
Pot. permanganate	..	..	..	1 ounce

When disease is suspected or confirmed, strengths up to three or four times the above may be used.

Formaldehyde gas must be liberated at some convenient place in the air circulation system, reasonably near the fan to ensure even distribution. Where space permits, the simplest procedure is to place the right quantity of permanganate into an enamel basin by either weighing it or measuring it with a tin or cup measure, and to add the required quantity of formalin to it after placing the basin in the incubator, the door being closed immediately afterwards.

It is advisable for the person handling formalin to wear gloves as it sometimes causes irritating sores. It is also necessary to lock the door of the incubator after putting the mixture in it, and to take precautions that it is not opened prematurely. The gas is produced quickly and can cause acute irritation to the operator's eyes and nose. A mask is advisable when working with high concentrations. Eggs must not be fumigated between the 24th and the 96th hours after setting, and chicks on hatching or about to hatch should not be exposed to fumigation.

Levelling of Incubator. The incubator when installed must maintain a perfect level. In case of hot-water machines, the even distribution of water will be affected if attention is not given to this detail. Levelling may be accomplished by the use of a spirit-level, and if the level is not even, suitable pieces of wood may be placed under the machine legs to bring it to the proper level.

Regulating Incubator. It is better to have a trial run of the incubator at the beginning of each hatching season, regardless of the incubator being new or old. The thermometer should be carefully tested by comparing it with a standard thermometer. The lamp burner should be thoroughly cleaned by brushing it free of all dust or charred material, and boiling it in a solution of washing soda. A good wick preferably new, of sufficient length to last during the incubation period, with its corners trimmed to give a round flame should be used. The chimney should be cleaned and should fit snugly. The lamp should then be filled and the machine given a trial run before placing the eggs. The thermostat should be regulated according to the manufacturers' instructions, and the machine operated at a temperature of 103° F. for at least 24 hours to make sure that everything is in order and ready for the hatch.

Placing Eggs. In placing the eggs in the trays it is best to arrange them in rows, either on their sides in case of flat-type incubators (Figs. 44, 49) or upright with the broad end up in cabinet-type machines (Fig. 50). Not more than one layer of eggs should be put on the tray; otherwise some will receive a higher temperature than the others. After placing the eggs in the machine it is advisable to start the heat in the morning so that it may be closely watched during the first twelve hours, to be sure that it is properly adjusted to requirements.

Regulating Temperature. The normal temperature of the hen varies between 105° F. and 107° F. and depends to some extent on her activity at the time. The optimum temperature at the centre of a hatching egg is about 100° F., and this is also recommended as the optimum temperature for cabinet incubation. This lower temperature is desirable because of the uniform temperature which surrounds all the eggs. In natural hatching under a broody hen the upper surface of the egg may attain 102° to 103° F. but the centre of the egg will not be more than 100° F.

For flat-type incubators the temperature recorded by the thermometer depends on the design of the incubator and the height of the thermometer bulb above the eggs. Experience has shown that most satisfactory results are secured with a temperature of 101° F. during the first week, 102° F. during the second week, and 103° F. during the third week of incubation. Precautions should be taken to see that the temperature does not exceed 104° F. at any time. The bulb of the thermometer should be on level with the top of the eggs, and so situated that reading can be made by looking through the glass of the incubator door.

Regulating Ventilation. Strong drafts blowing on or through the eggs should be avoided by placing the incubator in a properly ventilated room. During the growth of the embryo in the shell, foul gases are given off, and the chief passage for these gases is through the egg-shell at the large end, where the air-cell is located. As incubation progresses there is increased activity in embryonic growth with a consequent increased need for fresh air and the elimination of foul air.

Regulating Moisture. Lack of moisture will result in the drying of the developing embryo and its eventual failure to hatch. Special care is called for to supply plenty of moisture when the chicks are hatching out; otherwise the shell membranes become dry and too tough for the chicks to get out of the shell. It is more frequently necessary to supply additional moisture in hot-air incubators than in hot-water machines. Moisture may be provided by keeping the atmosphere of the incubator room at a high humidity level, by sprinkling the eggs with warm water at the time of turning, or by placing moist sand in the nursery compartment of the machine.

The best index for gauging the moisture and ventilation is provided by the size of the air-cell located at the large end of the egg. It is very small, about one-eighth of an inch deep at the beginning of the incubation period. At the end of the third day it should be about $\frac{1}{4}$ inch deep; on the eighth day about $\frac{3}{8}$ inch; on the fifteenth day about $\frac{5}{8}$ inch; and on the nineteenth day a little more than $\frac{3}{4}$ inch deep. The size of the air-cell may be ascertained by candling, and if there

is much variation from these depths the quality of moisture should be suitably modified.

Care of the Lamp. The lamp should be filled with fuel (kerosene oil) and trimmed at least once daily. This should be attended to in the morning so that any adjustments, if necessary, may be done during the day. The flame should be lowered before removing the lamp, to avoid smoking, and extinguished before filling it with kerosene, which should always be of good grade. The lamp should be cooled before being filled with kerosene.

The wick should be turned so as to be on level with the guide, and the charred part scraped off with a match or wiped off with a damp cloth. No trimming with scissors should be done, except where wick threads are barbed giving a ragged or smoky flame. A medium-sized flame is most desirable. The handling of the lamp should always be done after the eggs have been attended to, so as to avoid getting oil on the eggs which may lead to spoiling the hatch.

Turning Eggs. Turning of eggs is necessary to prevent the adhesion of the embryos to the shells. The usual practice used to be to turn the eggs twice during the 24 hours at nearly 12-hour intervals. Recent observations have indicated that somewhat better hatches may be secured by more frequent turnings—as many as six or eight in the 24 hours. With machines having a mechanical device for turning, such a practice is easy. Where eggs are to be turned by hand, at least morning and evening turning, should be rigidly followed. In order to do this, the tray should be removed from the machine, and one or two rows of eggs taken from the front should be placed at the back. The eggs may then be rolled forward with the palms of the hands so as to shift all of them sufficiently. When the tray is replaced, it should be given a quarter or half turn each time, so as to compensate any inequalities in the temperature of different parts of the incubator. The incubator door should be kept shut when the eggs are being turned and/or examined outside the cabinet.

Cooling Eggs. There is said to be no special value in cooling the eggs, except beyond the cooling which they get during the turning process. Where turning is done mechanically, as in mammoth machines, special cooling is not required. Turning should be done from the third to the eighteenth day (inclusive).

Testing Eggs. Machine-incubated eggs should be candled (tested) on the 7th and 14th day as explained under 'natural incubation'. The infertile eggs may be removed, hard-boiled, and later ground up as part of chicken ration. Dead embryo and chicks should be removed at each testing. This gives more room above the trays at hatching time, and saves air from being tainted by gases given off by the unhatchable eggs.

Care During Hatching. Generally, it is an indication of a good hatch if the chicks are out of their shells before the end of the 21st day. As activity increases with the pipping of the shells, the temperature is likely to run very high, and the moisture too low. The thermometer should, therefore, be closely watched at this time. The proper moisture condition is indicated by a slight mistiness or condensation of the moisture on the door glass.

On the 19th day the nursery tray should be placed, and the opening to it in front of the egg tray uncovered. The incubator should then be kept closed until the hatch is completed. As the chicks hatch they will work forward towards light and drop into the nursery. Chicks should not be helped out of shells. During the 22nd day the egg trays should be removed and all shells and unhatched or dead chicks removed and burned.

Care of New Hatch. The chicks which have hatched should remain in the incubator without any feed for at least 36 hours. When they have dried off and fluffed out, the temperature should be gradually reduced and more air allowed by opening the doors slightly. The temperature should be lowered to 93° or 95° F. as a means of 'hardening off' the chicks before transferring them to the brooder. Special care is necessary when removing the chicks to the brooder to prevent chilling by low temperatures or drafts. Crippled or weak chicks should be destroyed at this time, as they seldom live long and are usually a constant source of trouble because of their inability to grow up to be strong and healthy birds even if they survive their earlier disadvantages.

Faults in Incubation Techniques. The various possible faults in the technique of artificial incubation, their consequences, and the measures to be taken to remedy them are summarised in Table 11.

Table 11. FAULTS IN THE TECHNIQUE OF ARTIFICIAL INCUBATION, THEIR CONSEQUENCES AND REMEDIAL MEASURES

Trouble	Probable Causes	Necessary action
1. Too many clears or infertile eggs	a. Wrong proportion of males to females b. Males under-nourished c. Interference amongst the males during mating d. Frozen combs and wattles among the males e. Males too old f. Sterility in the male or preferential mating in pen matings g. Eggs kept too long or under wrong conditions before setting	a. Use one male to 10-18 hens of light breeds, and one male to 8-12 hens of heavy breeds b. See that the cockerels are able to get food separately otherwise they may allow the hens to eat all that is there c. Do not use too many males; always rear breeding males together; put up temporary solid partitions between breeding pens, or inside large pens d. See that the housing is comfortable and that proper drinking fountains are provided for the breeding pens. Dub males if they are in folds or low-covered runs in winter e. Replace the old birds with cockerels f. Replace with another male g. Do not keep hatching eggs longer than 7 days; store them in the cool 50° to 60°F at a relative humidity around 70 per cent or more
2. Blood rings, which indicate very early embryonic death	a. Incubator temperature too high or too low	a. Check thermometers, thermostats and current supply. FOLLOW THE MAKER'S INSTRUCTIONS

Table 11—Concluded.

Trouble	Probable Causes	Necessary Action
3. Many dead-in-shell	<i>b.</i> Incorrect fumigation procedure	<i>b.</i> See that the correct amount of fumigant is used. DO NOT FUMIGATE BETWEEN THE 24TH & 84TH HOUR AFTER SETTING
	<i>c.</i> As in 1 (<i>g</i>)	<i>c.</i> As in 1 (<i>g</i>)
	<i>a.</i> As in 2 (<i>a</i>)	<i>a.</i> As in 2 (<i>a</i>)
	<i>b.</i> Eggs not properly turned	<i>b.</i> Turn the eggs regularly at least three to five times a day; always turn the eggs in the reverse direction each time, never in the same direction
	<i>c.</i> Faulty nutrition of breeding stock, if deaths are heavy on the 10th to 14th day	<i>c.</i> Pay particular attention to the supplying farms from which the eggs come; check that the feeding is sound
4. Piped eggs failing to hatch	<i>d.</i> Faulty ventilation in the incubator	<i>d.</i> Increase the ventilation by normal means; additional oxygen is not needed at altitudes below 5,000 ft. above sea level
	<i>e.</i> B. W. D. (Pullorum disease) or other form of infectious disease	<i>e.</i> Use only eggs from sound, disease-free stock. Check that the hatchery hygiene is sound and is carried out
	Insufficient moisture in the incubator	Increase the evaporating surface of water or increase the sprays. Check the wet-bulb readings
5. <i>a.</i> Hatching too soon	<i>a.</i> Incubator temperature too high	Make quite sure that the temperature-regulating gear is efficient, and in particular that it is at the correct temperature when the current cuts off. If the temperature rises after this during a hatch, reduce temperature at which current cuts off
<i>b.</i> Hatching too late	<i>b.</i> Incubator temperature too low	
<i>c.</i> Sticky chicks	<i>c.</i> Incubator temperature probably too high	
6. Malformed chicks	<i>a.</i> Incubator temperature too high	<i>a.</i> As in 3(<i>a</i>)
	<i>b.</i> Incubator temperature too low	<i>b.</i> As in 4
	<i>c.</i> Eggs set incorrectly or not properly turned after setting	<i>c.</i> As in 3(<i>b</i>); also take care to set the eggs broad end up in cabinet-type incubators
7. Spraddling chicks	Hatching trays too smooth	Use wire-meshed tray floors or cover the slippery floors with burlap or other similar material
		<i>a.</i> As in 5
8. <i>a.</i> Weak chicks	<i>a.</i> Overheating of the incubator or hatching unit	<i>b.</i> Only set eggs of the recommended sizes
<i>b.</i> Small chicks	<i>b.</i> Setting small eggs	<i>c.</i> As in 4
	<i>c.</i> Too little moisture in incubator	<i>d.</i> As in 2(<i>b</i>)
<i>c.</i> Heavy-breathing chicks	<i>d.</i> Too much fumigant left in hatcher	<i>e.</i> As in 4
	<i>e.</i> Too much moisture in hatcher	<i>f.</i> Send chicks to a veterinary laboratory for diagnosis
	<i>f.</i> Possibly infectious disease	<i>g.</i> As in 3(<i>a</i>)
<i>d.</i> Mushy chicks	<i>g.</i> Low average temperature during period of incubation	<i>h.</i> As in 3(<i>d</i>)
	<i>h.</i> Poor ventilation of the incubator	
	<i>i.</i> Omphalitis, or navel infection	<i>i.</i> Carefully clean out and fumigate the incubator, using formaldehyde at the higher strength. Pay particular attention to the disinfection of all equipment
9. Hatch not coming off evenly	Setting eggs too diverse in age	Set eggs at least once a week and never retain hatching eggs longer than 10 days before setting



FIG. 49. ARRANGING EGGS ON THEIR SIDES IN A FLAT INCUBATOR



FIG. 50. ARRANGING EGGS WITH BROAD END UP IN A TRAY OF CABINET-TYPE INCUBATOR

FIG. 51. PEDIGREE HATCHING—*Top*: EGGS HATCHING IN CAGES; *Centre*: EGG MARKED WITH LEG BAND NO. OF HEN, PEN NO. AND DATE OF LAYING; *Bottom*: WING BANDING OF BABY CHICKS

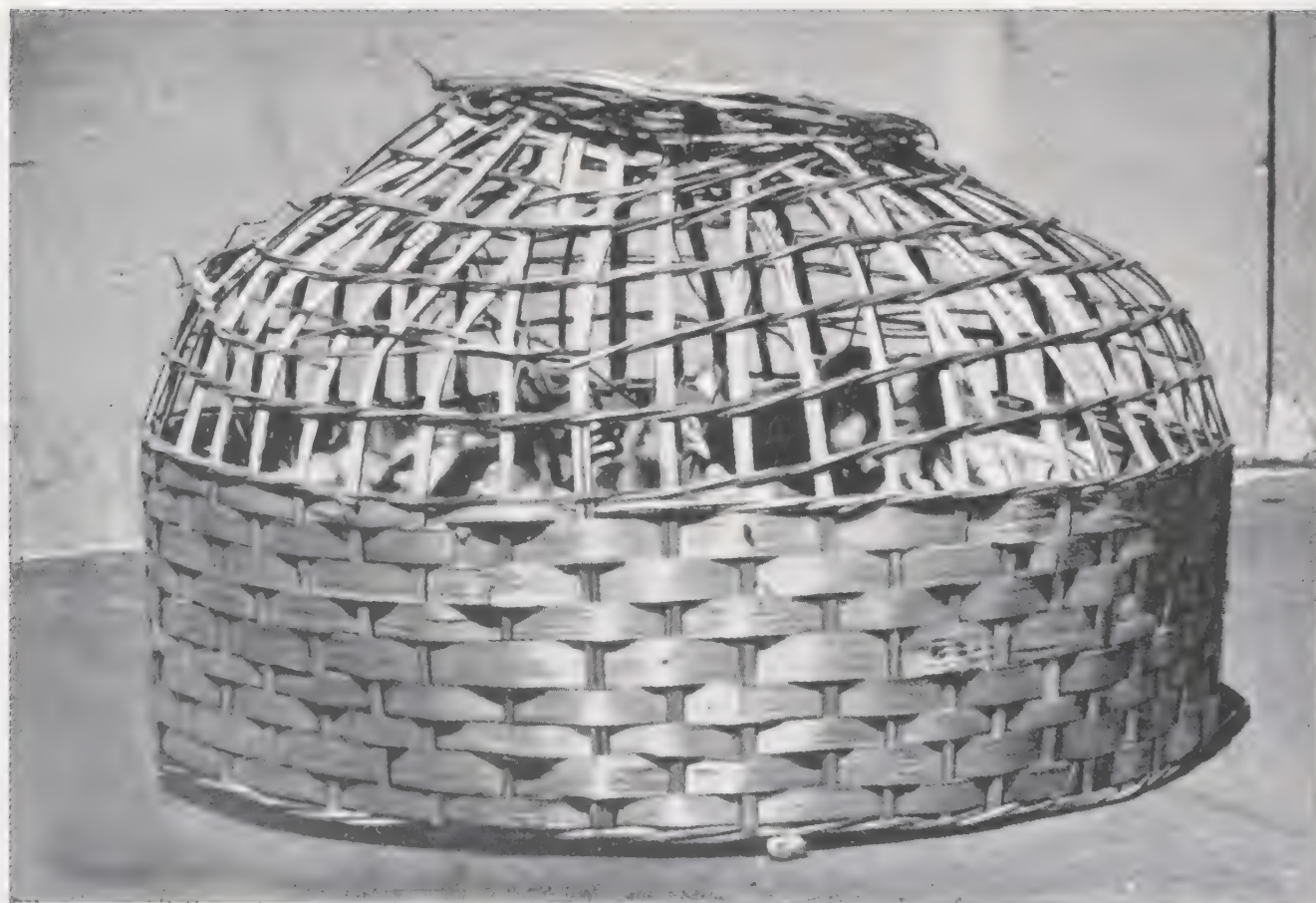


FIG. 52. A BAMBOO COOP FOR NATURAL BROODING

INCUBATION AND HATCHING

PEDIGREE HATCHING

In the preceding chapter it was stressed that for the improvement of a strain of birds for any particular purpose progeny testing of the breeding stock has to be undertaken, so that the parentage or pedigree of every chick may be known. This may be accomplished by marking the eggs laid by the female breeders with the leg-band number of the female laying the egg as well as with either the number of the pen or the number of the sire to which the female is mated (Fig. 51). On the 18th day of incubation the eggs of each female are placed in a separate wire hatching basket or mosquito-net bag, the former being preferable. At hatching time each chick is either wing-banded with a numbered metal band or toe-punched. There are 16 different combinations of toe-punching (Fig. 53) which facilitate identification of the chicks.

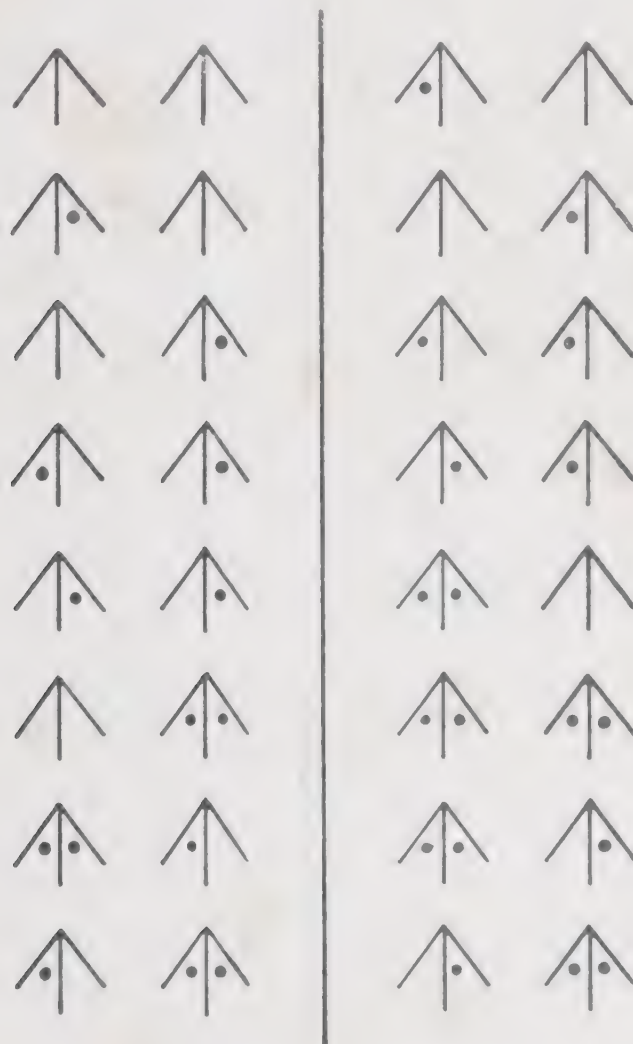


FIG. 53. DIFFERENT COMBINATIONS OF TOE-PUNCH MARKS FOR IDENTIFYING CHICKS

Day-old Chicks. With the increasing popularity of poultry keeping, the demand for day-old chicks must increase rapidly. Due to the expense of equipment and the detailed attention required in hatching chicks, many poultry enthusiasts,

and more especially backyard poultry keepers, should prefer to get day-old chicks by paying someone else for hatching them.

Just before hatching, the yolk membrane containing a quantity of embryonic nutrients is drawn into the chick's body (Plate 3), supplying it with sufficient nourishment for several days, so that the newly hatched chicks do not need any feed for 60 to 72 hours after leaving the shell. The chick is, therefore, said to be born with a 'lunch basket'. Its vitality is particularly strong during the first two or three days after hatching which allows it to be shifted over long distances in that period. It is a sound policy for intending poultry keepers who are making a small beginning, to start with day-old chicks as their nucleus of foundation flock. Purchase of day-old chicks is also of advantage when flock replacement or its increase has to be considered. The time and expense incidental to incubation are eliminated, while one could be definite about the number of chicks secured instead of having to reckon with the element of chance. Methods of rearing day-old or baby chicks so secured are dealt with in the chapter on 'Brooding and Rearing'.

It is important, however, to take certain precautions in purchasing day-old chicks. These are as follows:

1. The chicks, when meant for breeding, should be from pure-bred and high-producing parent stock.
2. The chicks should be secured only from flocks which are certified to be free from infectious diseases.
3. Only such chicks as are strong, vigorous and well developed should be accepted.
4. The chicks should be properly packed for transport so that they have the maximum comfort and are safe from chill.

8

BROODING AND REARING

BROODING and rearing relate to the growth of the chick after it is hatched, more especially to those factors that are more or less under the control of the poultry keeper. Having hatched the chicks, either by natural or artificial methods, the poultry man is confronted with the important task of raising them to maturity. There are two methods of brooding: the natural method and the artificial one.

NATURAL BROODING

Rearing a family is a natural process for the hen. She is both an incubator and a brooder and in this respect the *desi* fowl has no rival. Natural brooding is practically always used where the eggs have been hatched under hens. When only a small number of chicks is raised annually, as is generally the practice in India, natural brooding is probably more desirable and practical than the artificial method; the former involves less investment on equipment and may require less attention on the part of the poultry keeper.

Rearing Day-old Chicks. Normally a broody hen rears the chicks which she hatches, but she can also be made to look after the purchased day-old or baby chicks. For this purpose she has to be properly prepared. It is accomplished by placing under her, instead of a full nest of good hatching eggs, two or three table or infertile eggs or even dummy eggs. Every night these eggs can be removed for consumption and other eggs substituted in their place so that no eggs need be wasted. In this manner the hen can be kept broody till such time as the chicks arrive.

While the hen is sitting on these eggs, she should be treated in exactly the same manner as if she were hatching eggs. After she has sat for about a week or so, she is usually ready to receive the baby chicks. In some cases chicks can be introduced after the hen has been sitting for 2 or 3 days.

On the day on which the baby chicks arrive, two or three chicks should be placed carefully under the feathers of the broody hen prepared as above, preferably after darkness has set in. Generally, the chicks are accepted willingly. Subsequently, the remaining chicks can be introduced and the eggs removed. A good sized broody hen can easily be given as many as 12 chicks in cold weather, and up to 15 in the hot season.

Brooding Coop. It is advisable to provide the hen and the chicks a coop to protect them from enemies and inclement weather. The essential requirements of such a coop are dryness, durability, ventilation, cheapness, roominess and safety. Wire-enclosed runways are a desirable attachment for brooding coops. Barrels, boxes and A-shaped coops are commonly used. A bamboo coop (Fig. 52) which is made locally and is inexpensive, is largely used in the villages.

A cheap and satisfactory coop can be made by any local carpenter by using a packing case. It is approximately 2' 6" square, high in front with a good slope behind to carry off the rain. The front of the coop consists of slats 2" wide and 3" apart, the central one being loose and fitting into a socket in order that it may be taken out to admit the hen. The coop can be provided with a hinged night board that may be fixed at any angle during the day for shade and shelter. A wire detachable run may also be attached to the coop. This will serve as protection against kites, crows, hawks, cats, mongooses, snakes and other natural enemies of growing birds.

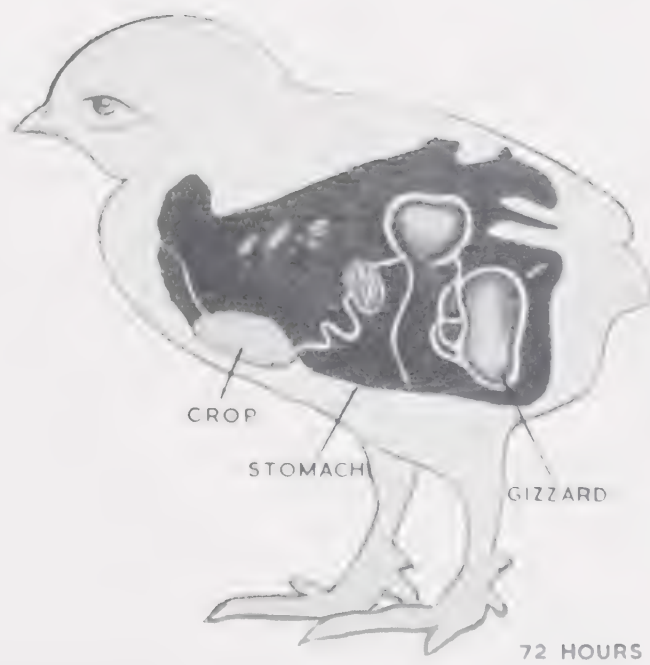
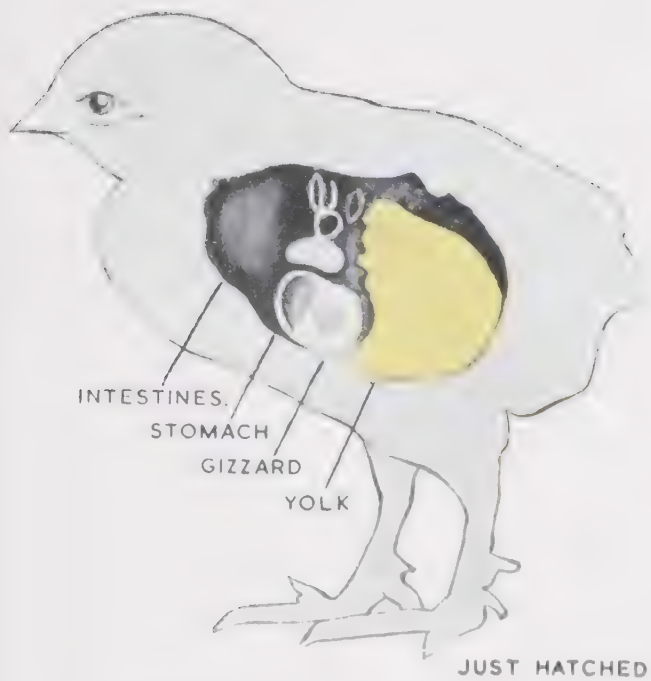
The coops should be placed on clean ground in a sheltered spot convenient for feeding the birds. The drainage should be good, and protection should be afforded against excessive sun, wind and rain.

Transferring Chicks to Coops. The hen and chicks should be transferred from the hatching nest to the coop preferably late in the evening after all the chicks have fluffed out well. The hen is best carried under one arm and the chicks in a covered basket, care being taken that the little ones do not get chilled. After first placing the chicks in the nest-compartment of the coop, the hen should be introduced. If additional chicks are to be given to the hen, they may also be added at night.

Frequent moving of the coop to a new location will prevent soil contamination and consequent losses from disease outbreak or parasitic infestation. It is also advisable to let the hen with her chicks in the sun for a short time once or twice a day.

Feeding Chicks. Chicks do not need feed of any kind within 36 hours after hatching. Some fine grit may, however, be scattered sparingly in the run preferably on a sheet of old newspaper and skimmed milk or buttermilk offered instead of water. The feeding of chicks, when brooded by hens, should not differ materially from feeding under artificial conditions of brooding. The hen may be of some service in securing greater feed consumption and in helping the chicks to learn to eat. During the first few days, feed should be provided at frequent intervals, in order not to overtax the digestive system of the chicks. It is too common a practice to depend on the hen for providing the feed to the chicks. This usually results in slow growth and unthriftiness. The feeding of chicks is dealt with more elaborately in the chapter on Feeding.

Feeding Hen. The hen should receive mixed grains twice a day and water should be available at all times. During the first few weeks the hen should be confined to the coop and the run so that she may not lead the chicks too far away. She should be released from the run only on days when the weather is clear and



Diagrammatic Representation of Yolk Absorption in the Body of Chick from the Time of Hatching



FIG. 56. PORTABLE LAMP BROODERS WITH ATTACHED RUN. (ABOVE RECTANGULAR TYPE, (BELOW) ARC TYPE



FIG. 57. BROODER FROM A PACKING CASE



FIG. 58. LAMP BROODER, RECTANGULAR TYPE SHOWING INTERNAL DETAILS

only after the grass has dried off in the late morning. In case the hen becomes sick, the chicks should be transferred to another hen or brooded artificially. Care should be taken to keep the chicks free of parasites and protected against predators. It is advisable to dust the hen periodically with sodium fluoride to keep her free of lice. The coop should be cleaned and sprayed regularly to hold mites and similar pests under control. Wire netting of suitable mesh should cover the top of the run and the floor of the coop to prevent damage from owls, hawks, cats, rats and other predatory animals.

ARTIFICIAL BROODING

Artificial brooding refers to handling of baby chicks without the aid of a hen. It is accomplished by means of a heated brooder (rearer, or as it is also called 'foster-mother'). Rearing chicks artificially has not yet been adopted widely in India, as most of our poultry units are small in size and the average number of chicks raised annually can well be taken care of by the *desi* hen, which is an ideal brooder and a good mother. However, in all countries where poultry keeping has made much headway, brooding of chicks by artificial methods has largely replaced the use of the hen. Artificial brooding has several advantages over the natural method, namely, (1) chicks may be brooded at any time of the year; (2) brooding may be done in large numbers; (3) sanitary conditions may be controlled; (4) temperature may be regulated; and (5) feeding may be undertaken according to plan.

Brooder House. The requirements for brooding are mainly those that concern housing; and a good brooder house is the first essential in artificial brooding. The house should provide good ventilation and protection against excessive temperature, and be free from drafts. The size of the brooder house depends on the number of chicks to be reared. If the number is large enough to warrant a large brooder house (Fig. 54), it is advisable to sub-divide it into a number of compartments, as good results cannot be had with rearing a very large number of chicks in one unit. On the other hand, very small units involve higher investment and higher running costs.

BROODERS

Brooders, rearers or foster-mothers as they are severally called, constitute by far the most important equipment used for brooding chicks artificially. They are made in various designs depending on the size, and the nature of fuel used to supply heat. They are available in sizes that can accommodate from 25 to 1,000 chicks.

The essentials of a good brooder are: a dependable mechanism for controlling temperature and regular supply of fresh air, dryness, adequate space, easy accessibility to direct sunlight, easy disinfection, protection against chick enemies, safety from fire, and economy in construction.

Cold Brooding. When it is not too cold, baby chicks can be reared successfully without any extra heat. This type of brooding is called 'cold brooding'. It is also known as 'hay-box brooding' because of the use of a small box or compartment, usually lined with fine hay. An ordinary basket somewhat thickly lined with fine hay and provided with a small hole or outlet to allow passage to the chicks often gives satisfactory results. Old flannel strips or feathers may be substituted for hay. A basket 15 inches in diameter can accommodate 30 chicks. While employing the cold brooding method it is necessary to confine the chicks, during the first 4 or 5 days, to a very narrow area around the basket by putting some kind of a guard or barrier all round. The object is to prevent chicks from straying away and getting chilled. For about one week or ten days the chicks should be confined to the basket at night. Very young chicks can be reared under conditions of cold brooding only when the surrounding temperature is high and there is not much difference between the maximum and minimum temperatures. Older chicks lend themselves to cold brooding more easily.

Fuel for Warm Brooders. The design of a warm brooder is governed largely by the kind of fuel used to supply heat. The most commonly used fuels are kerosene oil and electricity, and brooders operated on them are called lamp and electric brooders respectively. Most brooders are portable and can be moved from place to place. Portable brooders which are equipped with canopies for conserving the heat to a limited area near its source are called hovers.

Colony and Continuous Brooders. Colony brooders are those used for brooding chicks in lots varying from about sixty to a few hundred, while continuous brooders are those used for brooding chicks by the thousand, such as are installed by big commercial entrepreneurs.

The fuel used to supply heat in colony brooders may be kerosene oil, coal, wood, oil, gas or electricity. Continuous brooders are heated by coal, gas or oil.

Lamp Brooder. The lamp brooder is by far the simplest of the brooders, and can easily be made from an ordinary packing case. It is relatively inexpensive, and if made properly, usually gives satisfactory results (Figs. 56, 58). It can be heated by an ordinary hurricane lantern, which works quite satisfactorily providing the heat needed in the plains.

Basket Brooder. A very simple and inexpensive type of brooding equipment can also be made with an ordinary dome-shaped basket (Fig. 55). The lower half of the basket is lined with gunny sack or a cement mixture wash to prevent direct draft, and the upper half is left open to allow passage to smoke. The source of heat is a hurricane lantern placed in the centre and sleeved off by $\frac{1}{2}$ inch wire mesh to protect the chicks from getting burnt. The floor is covered with straw or sawdust to provide warmth and comfort. The number of chicks that can be accommodated depends on the size of the basket used for the purpose. The contrivance costs about Rs. 6, the lantern accounting for the major part of expenditure.

Brooder From a Packing Case. A wooden packing case about 3 feet long, 2 feet broad and $2\frac{1}{2}$ feet high, with its lid and bottom plank removed and replaced

by a sloped roof (for quick drainage of rain water) makes a satisfactory brooder (Fig. 57). The roof may be covered, if necessary, with zinc or tin sheet to make it impervious to rain. The floor is covered with $\frac{1}{2}$ inch wire-mesh and a hurricane lantern is placed at its centre to provide the source of heat. The wire net flooring allows the droppings to fall through, and safeguards chicks from diseases caused by insanitation. A little hay or straw can be spread on the floor during the first few days and gradually reduced till the chicks can rest on bare wire. To prevent the birds from burning themselves, the lantern is surrounded by a loosely fitting guard consisting of a square or circular sleeve or jacket of $\frac{1}{2}$ inch wire mesh or wire gauze. A chimney made of tin or zinc sheet to fit the top of the sleeve around the lamp and narrowing down to a tube which is led out of the box through a hole in its roof, provides an outlet to the fumes from the lamp. The chimney carries a little tin cowl on its external opening to avoid rain from getting in. A few circular ventilation holes are made along the upper part of the box, and a sliding door is provided at its lower part for the chicks to run in and out. The box is kept clear of the ground by placing it on corner rests about 2 inches long. This type of brooder is largely in use in U.P. and Maharashtra and costs about Rs. 10 including the lantern.

A still simpler lamp brooder can be made with a smaller packing case of say $1\frac{1}{2}$ feet square with one of its sides open for the chicks to enter. The top is a little raised to accommodate an ordinary hurricane lantern to provide heat. This type of brooder is used in a small room, the floor of which is covered with sawdust or straw. It can accommodate 50 to 100 chicks and costs about Rs. 7.

Improved Box Brooder. A simple and efficient brooder as described in the plan (Fig. 59) can be made locally by any carpenter. It consists of a rectangular box of cheap wood, 3 feet $\times$ 2 feet and 8 inches high, from which both the top and bottom planks have been removed. The bottom is covered with $\frac{1}{2}$ inch wire-mesh which constitutes the floor on which the chicks rest. The top consists of a 3 feet $\times$ 2 feet wooden frame covered with $\frac{1}{2}$ inch wire-mesh and hinged to the box to constitute a lid that can be opened and closed as the need be. Circular holes of

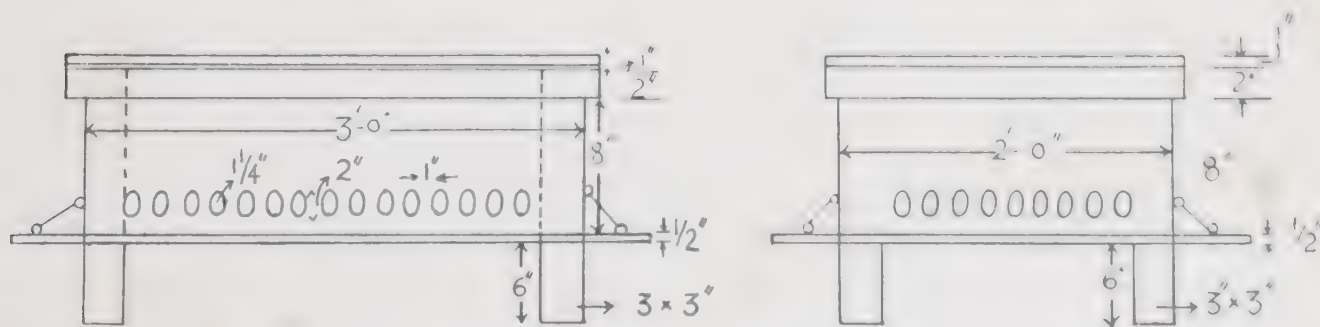


FIG. 59. CONSTRUCTION DETAILS OF A LAMP BROODER

Construction Details; All the four sides of the brooder are of 3 plyers wood in which the holes are cut for feeding arrangement. Top is covered with a frame which is completely packed by $\frac{1}{2}$ " mesh, bottom is to be covered with $\frac{1}{2}$ " wire mesh tightened by wires only. Feeding holes to be of $1\frac{1}{2}$ " $\times$ 2" and 1" space in between the holes. Feeding platform with hinges should be foldable to cover the feeding holes—look in arrangement and handle should be provided for the lid.

1½ inches diameter are made one inch apart all along the four sides of the box, about 1½ inches above the bottom to which horizontal wooden supports or platforms, 3 inches wide, are fixed all round. The box is mounted on wooden rests 3 inches high fixed to its four corners. Zinc-sheet feeding and watering troughs are placed on the platform all round. The source of heat consists of either a hurricane lantern sleeved off by ½ inch wire mesh all round or a 60 kw. electric bulb with a conical shade. This brooder can accommodate from 50 to 60 chicks.

The advantage of this type of brooder over the others is that it serves both as a brooder and chicken run. When there is bright sun, the lantern or the electric bulb is removed and the brooder is kept in the sun, half the top being covered by a gunny sack leaving the other half open, so as to enable chicks to come out in the sun or get under the shade provided by the covering. In the evenings and at night the lamp is replaced and lit and the entire top is covered with a gunny or old woollen blankets if it is cold. This is necessary for the first two or at the most three weeks of the chicks' life. After four weeks neither the top covering nor heating is necessary.

The floor of the brooder box should also be covered with chaffed clean dry straw or hay to be replaced at least once a week or more often if necessary, for at least two or three weeks, after which it can be done away with altogether. In order to prevent drafts from chilling the chicks, especially at night, the holes along the sides can be covered by the platform boards if they are fixed to the box by means of hinges.

Electric Brooder. Several makes of improved electric brooders are now available; and with the intensification of rural electrification, it would be possible to use these widely. The construction of the brooder is essentially the same as that of a lamp or oil-heated brooder, except for the fact that the source of heat is supplied either by electric bulbs or heating coils fitted at the top of the wooden or metal shade (Fig. 61). The efficiency of this brooder rests, however, on continuous availability of power current, as in the event of electricity failure chicks get chilled and die in large numbers.

If the cost of electricity is reasonable, brooding of chicks with an electric brooder is economical. A simple, cheap and efficient electric brooder is made by using, instead of hurricane lantern, four electric bulbs of 60 candle power each in the improved type of brooder box described above.

Selecting Colony Brooder. Selection of the type of brooder best suited for colony brooding is of very great importance when large numbers have to be brooded. It is desirable to buy a well-made brooder and to avoid cheap makes, which often prove unsatisfactory. When only a few chicks are to be raised, some kind of a lamp brooder is often justified, because of the relatively low initial expense. On the other hand, if a large number (a few hundred or more) of chicks are to be raised, one or the other types of electric brooders would be necessary (Figs. 62, 63). The larger the number of chicks brooded at a time, the less the brooding cost per chick. Best results are, however, usually secured, when not over 250 chicks are brooded together in each brooder.

BROODING AND REARING



FIG. 60. A SIMPLE AND EFFICIENT TYPE OF BROODER SUITABLE FOR VILLAGE CONDITIONS



FIG. 61. AN ELECTRIC BROODER

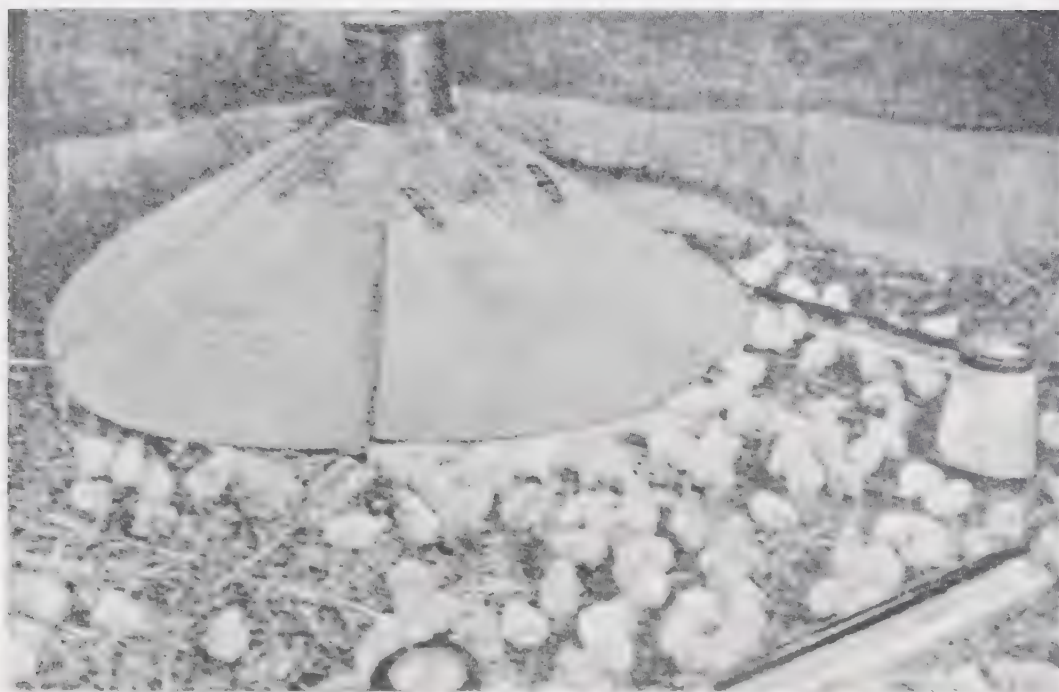


FIG. 62. AN ELECTRIC COLONY BROODER



FIG. 63. A COLONY BROODER OPERATED BY ELECTRICITY: NOTE THE FEEDING AND DRINKING UTENSILS

BROODING AND REARING



FIG. 64. ELECTRIC BATTERY BROODER

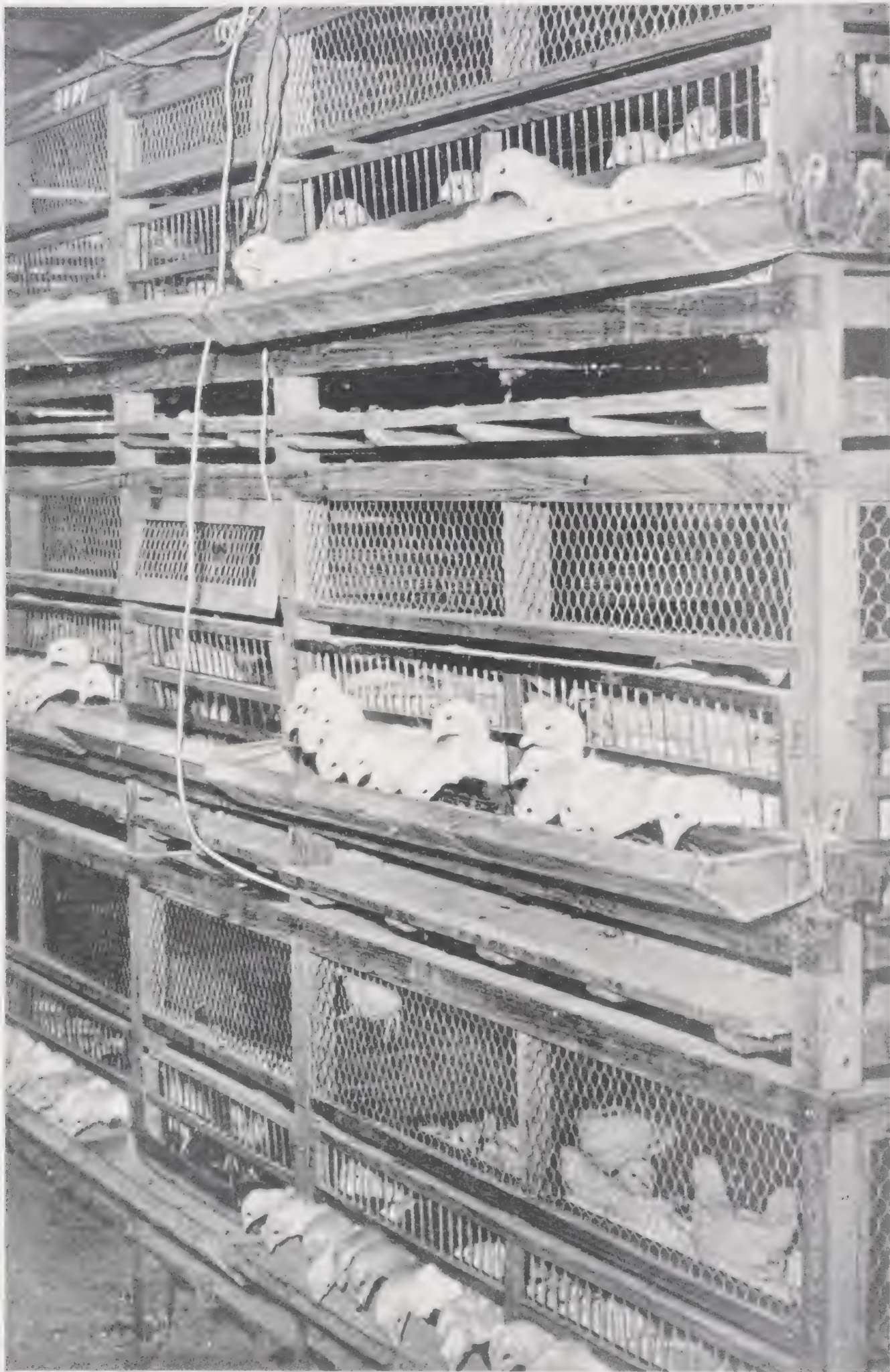


FIG. 65. HOME-MADE ELECTRIC BATTERY BROODER

Under normal conditions chicks grow rapidly doubling their weight approximately every 2 weeks up to the age of about 6 weeks. It is, therefore, easy to understand why chicks soon become badly over-crowded if too many are placed in the brooder at the start. The larger the number of chicks brooded as a unit, the lower is the growth usually and the greater the mortality. It is, therefore, advisable not to brood more than 250 chicks per brooder.

Brooder Space: Adequate space and proper ventilation are so important for successful brooding of chicks that every care should be taken to conform to correct dimensions. Light-breed chicks require from 7 to 10 sq. inches of floor space each and the heavy breeds from 10 to 12 sq. inches. A brooder of the size of 2 feet long, 2 feet broad and 10 inches in height is big enough to accommodate 50 to 70 chicks. Similarly, a brooder one foot square just suffices for rearing 20 chicks. In the brooder house, each chick should be given at least one-half sq. ft. of floor space, which means that 100 chicks should be given at least 50 sq. ft.

Brooder Temperature: The brooder must be given a trial for 2 or 3 days before placing the chicks in it, to ensure that it maintains a steady temperature. To start with, the temperature inside the brooder should be 95° F. at about 2 inches above the floor level. The temperature should be reduced by 5° F. each week, depending on the time of the year and the outside temperature, until it reaches 80° F. by the 4th week after which it is maintained at that level.

There are no hard and fast rules about the correct amount of warmth required for brooding chicks. It has to be determined by one's own judgement and experience. The main point in brooding is to maintain such temperature in the brooder house as will keep the chicks comfortable at all times. The poultry man should, therefore, be thoroughly acquainted with the behaviour of the chicks under varying temperature conditions, and be able to tell immediately by the reaction of the chicks whether or not they are comfortable. As a rule, excessive heat causes the chicks to pant and may even cause them to crowd into the corners of the brooder house in an attempt to get away from the heat. On the other hand, too low a temperature will cause them to huddle together either under the hover or in the corners of the brooder house. If the chicks are comfortable,

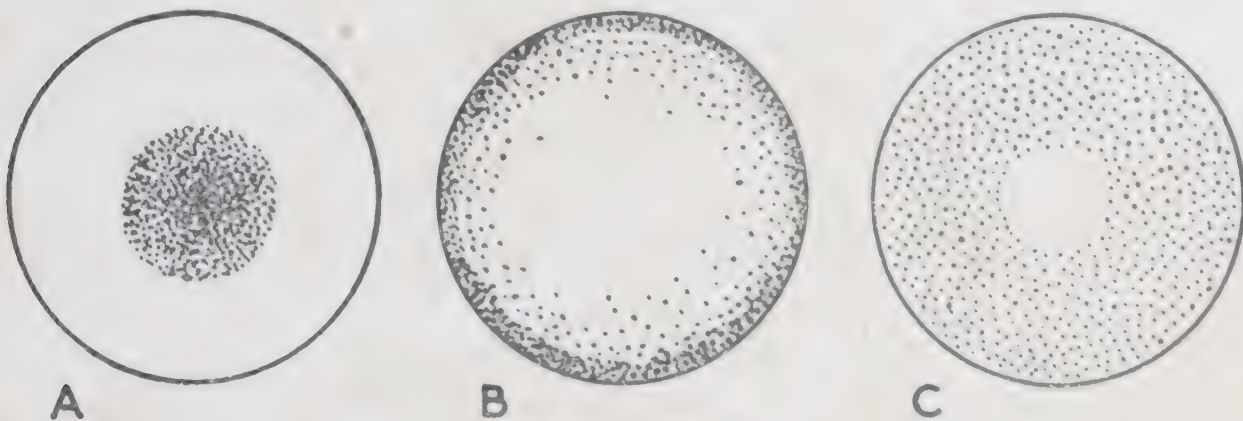


FIG. 66. DISTRIBUTION OF CHICKS UNDER THE HOVER CANOPY

A—Too low temperature B—Too high temperature C—Correct temperature

they will spread out evenly under the hover of the brooder (Fig. 66C). If the brooder temperature is too low the chicks will huddle together round about the source of warmth (Fig. 66A) whereas when the brooder temperature is very high they tend to migrate towards the periphery where they huddle together (Fig. 66B).

Litter in Brooder House: In colony brooding it is necessary to provide a good litter on the floor to protect the chicks from cold damp floor and to help maintain sanitary conditions in the brooder house. The whole floor including the area under the hover should be covered with litter. Wood shavings, chopped hay and paddy straw make a good litter which is fairly absorbent besides imparting a bright and cheerful appearance to the brooder house. Ordinary clean sand, sawdust, groundnut, coffee husk, etc., can also be used as litter wherever they are available instead of hay or straw, although they are not ideal for the purpose. The litter should cover the floor to a depth of two to four inches and should be stirred over every morning and changed once a week or oftener if it becomes damp or very dirty with the droppings. Any unusually moist patches in the litter such as may be caused by the spilling of drinking water should be removed promptly and either replaced immediately by fresh dry litter or the rest of the litter spread to cover up the area.

Battery Brooders. Battery brooders are special contrivances designed to accommodate a large number of chicks on a limited space for a short period of time. They are, no doubt, very useful in housing chicks from the hatching time till they are about four weeks of age, but the initial heavy investment which they entail stands in the way of their becoming popular.

A battery brooder consists of several brooding compartments built in tiers one above the other (Fig. 64). Each compartment consists of a brooder which is heated either by an oil lamp or electricity and is provided with a wire floor, under which there is a metal pan (dropping board) for collecting droppings. Dropping boards may also consist of a mechanically operated rolling band of water-proof cloth which can be cleaned frequently or of paper which can be removed periodically. A cooling compartment or run is also attached to the brooding compartment, so as to permit free movement of chicks from the brooding to the cooling compartment. Adjustable feeding and water troughs are placed around outside each compartment. Battery brooders are at present generally imported and require heavy investment. It should be possible, however, to make them locally at a considerably lesser cost. Fig. 65 shows a locally constructed battery brooder used on the Kasetsart University Poultry Farm at Bangkok, Thailand.

The outstanding features of a battery brooder are: a relatively large number of chicks can be brooded in a comparatively small space, low mortality rate and economy in the cost of raising chicks.

SEASON FOR BROODING

Whatever the method of brooding adopted, it is essential to keep the young chicks warm and comfortable and fed on well balanced diet. As the environmental conditions outside the brooder are of vital importance, best brooding results

can be obtained only by rearing chickens at certain periods of the year. In northern India, the best growth results are normally obtained during the cold months of November to February. From February onwards till the break of the monsoon, growth declines progressively with the rise in temperature. On the other hand, in the South optimum growth conditions are to be found between the months of June and September. It is, therefore, essential that the poultry keeper should himself determine the brooding and rearing season best suited to his conditions.

REARING

Regardless of the system of artificial warm brooding adopted, the chicks should be shifted to a rearer, which is simply a chamber of rather larger proportions without a lamp or any other source of heat, as soon as they are weaned. A well ventilated room, a rectangular or A-shaped portable coop will serve the purpose. While transferring the chicks from a warm brooder to a rearer, care and judgment should be exercised to avoid the effect of any sudden change.

Rearing Coops. A somewhat more expensive but very efficient way of rearing chicks is by means of coops with wire-mesh bottom, so that the chicks grow up to about 8 or 10 weeks off the floor and, therefore, have no chance of coming in contact with the droppings. These rearing coops can be either portable or stationary. The box type of brooder referred to already serves the purpose of a rearing coop for chicks aged 4 to 6 weeks old (Fig. 67). A rectangular coop of larger dimensions can be used for rearing chicks from 4 to 8 weeks and is also inexpensive. The stationary type of brooder is at its best with a combination of a brooder room or chamber and a chicken run, each room and pen being adequate to rear from 150 to 200 chicks (Fig. 68). A long row of rearing units can be constructed by partitioning a bigger building and will be used for the brooding and rearing of larger number of chicks (Fig. 54).

A more ideal rearing equipment consists of a built-in type housed in an existing building, suitably altered, if necessary, to provide proper ventilation and freedom from drafts, or one that is constructed for the purpose. Here both the brooder and the outside run are provided with wire-mesh flooring at a suitable height over ground level so that the chicks do not come in contact with the ground. The outer run in such a brooder serves the purpose of a sun-porch.

Battery Rearers. Battery type of chick rearers constructed on the same lines as battery brooders, but with larger dimensions and without any provision for heating are also used for rearing large number of chicks, especially broilers. Their use in this country is, however, subject to the same limitations as battery brooders.

In this method of raising chicks there is usually less risk of chick mortality because the birds are protected from the droppings-contaminated soil during the most vulnerable period of their growth. Chicks are generally reared in these brooders for 8 to 10 weeks during which they are also protected against the most common contagious diseases like Ranikhet and fowl pox, when they are transferred to a fresh enclosure or on a clean ground.

Rearing Out-doors. The practice of allowing the chicks out-of-doors at a fairly early age is very sound, provided they are protected from predatory animals and birds by enclosing the run on the sides as well as the top by chicken wire-mesh. Such a protection is not necessary for grown up chicks except during night times. Under out-door conditions, the chicks obtain ample exercise and receive the full benefit of sunlight which helps to keep them healthy and promotes the development of bones. Ample shade is, however, essential in the runs and can be provided by planting quick growing evergreen trees, such as fruit trees, mulberry, etc (Fig. 69).

Chicks confined behind ordinary window glass require special feeding; otherwise they suffer from leg weakness after three to four weeks. Shark liver oil is a good substitute for sunlight, but it is better if the chicks could have access to direct sunlight and outdoor life from an early age.

If land is available and chicks could be safeguarded against predators, sunshine and green grass on the range offer ideal conditions for raising chickens. A good grass range provides succulent green feed and reduces the feed bill. It also minimises the chances of feather picking, cannibalism, parasitic infestation and disease infection.

A good chicken range should provide an area of approximately 100 feet $\times$ 100 feet for every 100 chicks. In order to ensure clean range, the land on which chicks have been ranged should not be used again for at least another year. Rotation of the range is, therefore, desirable if best results are to be obtained.

Rearing on the range requires suitable portable shelters for protecting the growing stock against severe sun and rain and also for housing them at night time.

Cleanliness. Cleanliness of brooders, brooder rooms and rearing equipment is of paramount importance. All the sanitation and hygienic measures detailed under hatching and incubation in the preceding chapter apply equally well to brooding and rearing.

BROODING AND REARING



FIG. 67. SIMPLE REARING COOP OR COLD BROODER



FIG. 68. STATIONARY BROODERS



FIG. 69. CHICKEN RUN WITH GOOD SHADE PROVIDED BY FRUIT TREES

HOUSING AND EQUIPMENT

PROPER housing is one of the pre-requisites of sound poultry farming. Among the essentials of good housing are: comfort, safety, economy and convenience.

To be comfortable a house must provide adequate accommodation; by reasonably cool in summer, free from drafts, and sufficiently warm during the winter; provide adequate supply of fresh air and sunshine; and remain always dry. A fowl has no sweat glands to regulate its body temperature. In severe climate the birds would, therefore, suffer much unless special care is taken about their housing. Moreover, a good part of their feed is used up for maintaining the body heat instead of being available for growth or egg production. A house which is ill-ventilated, insanitary and uncomfortable (Fig. 70) makes for low production, poor fertility, impaired health, and high mortality.

It is necessary to provide safeguards against theft especially at night, and attack from natural enemies of the birds such as fox, jackal, dog, cat, mongoose, rat, hawk, kite, crow, snake, etc. The birds should also be protected against external parasites like ticks, lice and mites.

A poultry house need not be expensive. It should, however, be durable and provide for the comfort and safety of the birds. In constructing the house, locally available materials should be used as far as possible, with due regard to their durability. The more durable the house the less will be the cost of maintenance.

The house should be located at a convenient place, and the equipment so arranged as to allow cleaning and other necessary operations to be done with ease.

HOUSING PRINCIPLES

An ideal or a well-constructed poultry house is one which would help conserve the birds' energy, make for economy in feed, increase egg production, improve fertility, promote health and growth, and keep mortality low. It is difficult to conceive of any single house type that would suit all conditions. Housing patterns would vary according to differences of climate and systems of poultry keeping. However, there are certain general principles which should be observed.

In the hills, for instance, warmth and shelter from rain and wind are desirable, and any of the modern types of houses which are used in the West may be adopted depending on the system of poultry keeping practised. In the plains of the North or in any other part where there are extremes of temperature, poultry houses should be cool in summer and warm in winter. Houses which are open on all sides and provided with an additional shelter of thatched grass on the top would do well in summer. In the cold and rainy weather canvas or bamboo curtains may be fixed to three sides of the houses for warmth and protection. In the maritime and low lying areas, where it is always warm, open houses which give shelter and shade suffice. A house with wire netting on all sides, with the floor clear of the ground, and a good large roof will be quite suitable.

Some of the important principles of sound housing are discussed below:

Selection of Site. In selecting site for a poultry house the following considerations should receive attention:

(i) The site should provide natural facilities for the ventilation of the house, but should be free from drafts. The house should be so located that its rear faces the direction from which the gales usually come. Normally, exposure to western and north-western winds is to be avoided.

(ii) It should not be in low depressions as cold and damp air usually tends to settle in such places.

(iii) For safety from fire it should be located at some distance from dwellings and other farm buildings. However, it should not be so far away as to render proper supervision and care of the stock difficult.

(iv) Plenty of sun should be available at the site, but since the birds would need protection against the heat of the day, especially in the northern parts, provision should also be made for sufficient natural shade. Trees and bushes should not, however, be too close to the site or too low, for otherwise the soil would remain damp and harbour diseases. For this reason too close proximity to forests has to be avoided as that causes dampness.

(v) The soil in the vicinity of the house should preferably be sandy loam as that provides good drainage and is also suitable for growing grass and other green crops. Heavy clay soils, as also soils which are excessively saline, are not good. Soft and muddy soils are also unsuitable.

Housing Hygiene. The house should remain absolutely dry. Dampness causes discomfort to the birds and also gives rise to diseases like colds, roup and pneumonia. Moreover, mash and other feeds become sour and mouldy in damp air.

Dampness in the poultry house may be caused by: (i) moisture rising through the floor; (ii) leaky roofs or walls; (iii) rain or snow entering through the windows; (iv) leaky water containers; and (v) exhalation of the birds. The floor should be paved with impervious material, and should be $\frac{1}{2}$ '-1' above the level of the surrounding ground. The roof must be water-tight and should overlap the house by at least a foot on all sides. In heavy rainfall areas it should be kept very low (Fig. 71). It is also advisable to fix up curtains of gunny cloth or bamboo mats on the

HOUSING AND EQUIPMENT



FIG. 70. ILL-VENTILATED AND INSANITARY POULTRY HOUSES



FIG. 71. A POULTRY HOUSE WITH LOW ROOF FOR HEAVY RAINFALL AREAS



FIG. 72. A COLONY HOUSE WITH ASBESTOS SHEET ROOF



FIG. 73. A SHED-ROOF TYPE STATIONARY HOUSE



FIG. 74. A STATIONARY HOUSE SUITABLE FOR HILLY AREAS

HOUSING AND EQUIPMENT

sides to prevent rain from getting into the house. Dampness on account of the exhalations of the birds may be avoided by providing proper ventilation and sufficient air space in the house.

Ventilation: Compared to other livestock, the fowl has a higher body temperature and breathes much faster. Its requirement of oxygen is, therefore, comparatively larger, as may be seen from Table 12.

Table 12. DAILY (24 HRS.) REQUIREMENT OF FRESH AIR PER 100 LB. LIVE WEIGHT

Animals				Space required		
Man	..	..	..	2,833	Cubic feet	
Cow	..	..	..	2,804	„	„
Horse	..	..	..	3,401	„	„
Poultry	..	..	..	8,278	„	„

Moreover, the amount of moisture thrown off by birds while breathing is larger than that exhaled by other livestock. The need for good ventilation in poultry houses is, therefore, obvious. This can be ensured by providing houses open on all sides, excepting the lower one-third portion of the rear and the sides which may be covered by a wall or asbestos sheets to keep away drafts. The open space is covered by a one-inch wire mesh. In cold and rainy seasons the house is covered on all sides, except the front, by canvas, old gunny cloth or mats made from locally available materials such as bamboo, *khus khus*, etc. Additional shade is necessary during the summer, and is provided by thatching the roof.

Sunlight: Sunlight in the poultry house is desirable not only because it brightens the house and makes the birds happy, but also because it keeps the house dry and destroys disease germs. Moreover, sunlight is also a source of vitamin D which is needed for building up the skeleton (bones).

Sanitation: Poultry houses generally abound in lice, ticks, fleas and mites, which are among the worst enemies of the birds. They not only retard growth and laying, but also transmit diseases. The house should, therefore, be so designed as to admit of easy cleaning and spraying. Cracks or crevices should be reduced to the minimum. Angle irons for the frame and cement asbestos or metal sheets for the roof and walls are ideal construction materials, as they permit effective disinfection of the house to be carried out with a direct flame, whenever required.

When wood is to be used in the construction of poultry houses, there should be a minimum of joints and cracks. In the case of small units the legs of the framework on which the house is constructed should rest in a small tin or earthen cup containing kerosene oil. Every piece of wood used as building material should be treated with coal-tar, creosote, or similar strong insecticides before being fitted.

Adequate Room: Putting too many birds in a house is false economy inasmuch as over-crowding gives rise to one or more of the following conditions:

- (i) Heavy mortality as a result of easy spread of diseases.
- (ii) Excessive dampness.
- (iii) Feather picking and cannibalism.
- (iv) Malnutrition as a result of difficulty of access to the feed.

The size of the house would depend on the size of the flock, nature of the breed, and on whether the birds are confined to the house or allowed free range. The smaller the flock the larger the floor area required per bird. Thus, if only a few Leghorns are kept, they would each require from 6 to 8 sq. ft. of floor area, while if a flock of 150 fowls is to be maintained, an allowance of $3\frac{1}{4}$ sq. ft. per bird would be sufficient. Barred Plymouth Rocks and Rhode Islands would require 4 sq. ft. each in a flock of 150 birds.

The following Table gives the space requirements for different sizes of flocks when they are confined to the house. If the birds have access to a range or a run attached to the house this accommodation would be enough for double the number.

Table 13. SPACE REQUIREMENTS OF POULTRY FLOCKS

Floor Area (Sq. Ft.)			Accommodation Enough for	
			Leghorns	Heavy Breeds
24	..	..	6	5
48	..	..	12	10
64	..	..	15	12
100	..	..	25	20
224	..	..	60	50
400	..	..	125	100
576	..	..	180	144
600	..	..	190	150
900	..	..	280	225
1,600	..	..	500	400
3,200	..	..	1,000	800

Laying pullets and hens usually lay better when kept in small units of, say 15 to 25 birds. Large flocks require less labour and a lower housing cost per bird than small flocks, but there is greater risk of high mortality because of the increased chances of spread of disease. Generally, 250 layers are to be regarded as the maximum number that should be kept together. For keeping such large

numbers, a colony house is to be preferred (Fig. 72). In commercial poultry farms, having 1,000 layers or more, it is advisable to form units of about 125 birds per pen. Long houses should be partitioned at every 20 feet so that drafts are eliminated.

POULTRY HOUSE

The more nearly square a building is, the more economical it is to build. The deeper a house is from front to rear, the more comfortable it will be in the back part where the birds roost. Narrow long houses are relatively more expensive to build because of their greater perimeter. The major structural features are dealt with below.

Roofs. There are several recognised roof-types used in poultry houses. Each of these has its own advantage, but not all are equally satisfactory under all conditions. The type of roof varies generally according to (i) the system of poultry keeping intended to be followed, and (ii) climatic conditions.

The following systems of poultry keeping are usually recognised and have been dealt with in an earlier chapter:

- (1) Backyard poultry keeping
- (2) Free range system
- (3) Semi-intensive system
- (4) Intensive system

For all these systems there is a wide range of housing designs which are considered in this chapter. Each poultry keeper can, therefore, exercise his discretion of making a suitable choice, bearing in mind the essential principles and his requirements.

While designing a poultry house and providing a suitable roof for it, the principle of providing adequate protection against sun, rain, wind and winter should be borne in mind. The roof should be such as to help exclude drafts of wind, rain and snow, while providing for good ventilation, sufficient head room, simplicity of construction and economy. Types that are suitable for this country are described below.

Shed-type Roof: The shed-roof house, also called the lean-to-type, is by far the most useful and practical type of house that can be used under different climatic conditions and for different systems of poultry keeping. It is also the simplest and most economical to construct. The slope of the roof needs only be slight in the plains, while in the hills where snowfall is heavy or in heavy rainfall areas, it ought to be sufficiently steep.

The shed-roof type of houses may be either portable or stationary. The portable houses are more desirable for being used under farm conditions, while the stationary ones are convenient for backyard poultry farming.

The portable house is generally a small one, not exceeding 8'×6', the most convenient size being 6'×5' roughly. It can be shifted quickly from place to place and that is its great advantage. Its one disadvantage, however, is lack of room for accommodating larger flocks. It is, therefore, well suited for free-

range system of poultry keeping, and may also be used in a semi-intensive system, in which the birds can be let out for the major part of the day, and all feeding and watering is done outside the house.

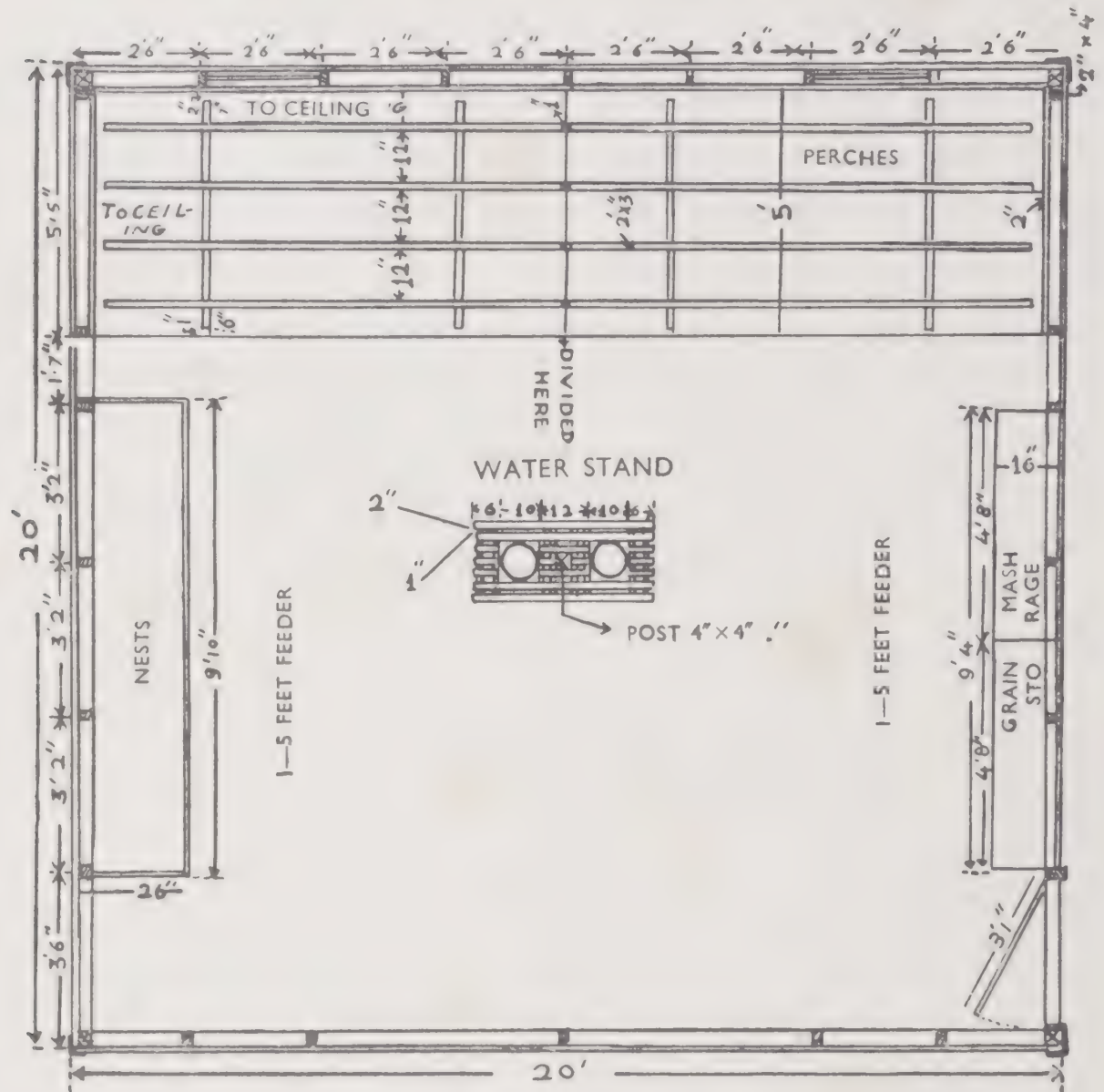


FIG. 75. FLOOR PLAN FOR A 20×20 FEET SHED-TYPE LAYING HOUSE

The stationary type (Fig. 73) can be made of any dimensions. Such a type is best suited for backyard poultry farming as well as for the semi-intensive and the intensive systems. It is especially useful for the backyard poultry keeper in urban areas where there may not be any extra space for letting the birds out, or even if some space is available it is occupied by a kitchen or flower garden to which the birds would prove very destructive. The risk of damaging the neighbour's garden has also to be taken into consideration if birds are to be kept in the backyard of urban dwellings without being properly confined.

The stationary houses differ from the portable ones in that they provide for the feeding and watering of the birds inside the house. In these houses the birds are not let out at any time. Provision for feeding the birds inside the house also keeps



FIG. 76. POULTRY HOUSE WITH EXPANDED METAL FLOOR



FIG. 77. POULTRY HOUSE CONSTRUCTED WITH SPLIT BAMBOO



FIG. 78. TRAP NEST AND FEED HOPPER



FIG. 79. FEED HOPPER FOR ADULT BIRDS

the crows and monkeys away, besides keeping the mash dry and providing shade to the water. Figure 75 gives the plan of such a house.

Gable or Even-span Roof: The construction of the even-span-roof house is not only more difficult but also requires more investment than the shed-type house does. The A-shaped type is more or less a high pitched gable roof set on low walls. Its advantage lies in being more economical to construct than the even-span roof.

The even-span and A-shaped type of houses are of advantage in heavy rainfall areas, the latter being preferred in regions of very heavy rainfall and more especially in the hills where snow is plentiful. The steep slope prevents accumulation of the snow and water.

Both the types can be made either portable or stationary. The portable houses are suited for free range and folding systems of poultry keeping.

Broken or Uneven-span Roof: The broken or uneven-span roof, which is generally of two-thirds span is frequently used for extra deep houses and for long houses where considerable head room is desired. The shorter slope of the roof is most frequently placed towards the south allowing a larger area of the wall in front. Such houses are more attractive in appearance.

Monitor Roof: Where the houses are of great width and the pens are placed on either side of a central alley, the monitor type of roof is preferred. This is particularly recommended for the construction of brooder house and chick rearing house. The monitor-roof house should be constructed with the pens facing north and south, thereby permitting equal illumination from east and west. These houses are more expensive to build. The advantages, if any, of this type over the others are not commensurate with the higher cost of construction.

Half or Semi-monitor Roof: A variant of the monitor-roof type is the half or semi-monitor roof. It is also intended to provide for the lighting of a deep house, and serves the same purpose as the monitor type. It is also expensive to build.

Roofing Materials. A very satisfactory and durable roofing material is cement-asbestos sheeting, but it is expensive. Equally durable and less expensive, but not equally satisfactory roofing material is corrugated iron or zinc sheets. The metallic sheets, however, get very hot during the summer and cause great deal of discomfort to the birds. During winter, the moisture emitted by the breathing of the birds collects on the inner surface of the sheets and drips into the fowl-house contributing to its dampness. It is necessary to provide a *chhappar* or thatch over zinc-sheet roofed houses during summer, or to shift the house, if portable, to a shady place. The iron sheets can also be covered with grass, hay or palm leaves. Zinc sheets are suitable for roofing in regions of temperate climates where the temperature does not fluctuate much from season to season.

Cheaper roofing, which keeps the houses cool during summer and warm during winter, is provided by a thick thatch of dried hay or straw. Such roofs need frequent replenishment. They are also not impervious to rain. Improvement may be effected by covering the thatch with a gunny sack treated with cement-lime mixture, the treated gunny being well secured by nailing its edges to the wooden framework of the roof.

The cement-lime mixture consists of :

Cement	..	..	..	12 pounds
Lime	..	..	..	3 pounds
Common salt	..	..	..	1 pound
Alum	..	..	..	$\frac{1}{2}$ pound
Water	..	..	..	20 pounds

The mixture is prepared as follows:

Stir the cement and lime vigorously in water to obtain a thick solution. Add common salt and alum and go on stirring till all the ingredients are well mixed. The mixture is ready. It should be applied with a brush, once on the inside of the gunny sack and twice on the outside and allowed to dry in the sun. The gunny sack stiffens on drying and is rendered impervious to rain.

Floors. Next to the roof, the floor is an important item in the construction of a poultry house. The flooring should be such as to prevent dampness and to keep vermin (Fig 76) including rats, and other rodents from burrowing themselves inside the house.

Wire-mesh Floor. For the portable houses, the best flooring consists of wire-mesh or preferably mesh of expanded metal. The latter is more expensive but stronger and more durable, and does not sag like the wire-mesh. 1" x 1" mesh of expanded metal nailed to the bottom of the house makes excellent flooring through which all the excreta drop out ensuring best sanitary conditions. 1" x 1" chicken wire-mesh, if used in place of expanded metal, has to be reinforced by means of a few cross pieces of thick binding wire.

Concrete Floor. In the stationary poultry houses the best flooring consists of cement or concrete. Properly constructed floors although somewhat expensive initially, are damp-proof and rat-proof, are more durable, and can be kept more sanitary than other types of floor excepting wire-mesh floor.

Katcha Floor. *Katcha* floor is no doubt the cheapest, but it is difficult to keep it clean. The floor usually becomes foul, harbours disease germs and vermin, and provides favourable conditions for the onset and spread of diseases.

In case the heavy initial cost precludes the use of the flooring recommended above, a reasonably good clay floor can be provided by digging the area to be occupied by the house to a depth of one foot and filling up the pit with gravel, sand and small stones to a height of about 6 inches above the ground level. After ramming the materials tightly into the pit the surface is finished off with moist clay. After this a narrow trench around the edges of the house is dug into which is lowered to a depth of one foot, wire-mesh of one inch. The upper edge of the wire-mesh is nailed to the lower edge of the sides of the house, and the trench filled up tightly with mud. This is to prevent rats and mongoose from entering the house by tunnelling or burrowing through the floor.

Whatever the kind of flooring, it is desirable to provide some dry clean litter as bedding. For houses with wire-mesh flooring, litter in the form of hay or straw is necessary only during very cold winter months. The litter may consist of chaff, hay, straw, wood shavings, dry leaves, sawdust, sand, coffee, and groundnut husks.

Walls. Except for the hills where summer is cool and winter very cold, open-type houses with necessary adaptations prove quite suitable.

For Hill Areas: In the hills, a house with a partially open-front and closed on the other three sides with adequate provision for ventilation, is recommended. The walls of the house are made of brick or cement-asbestos sheets. Sun-dried bricks or mud may also be used. The walls should be solid and free from cracks, so that insect pests may be guarded against.

Ventilation secured with an open front allows the air to circulate without blowing too strongly on the birds. All ventilation holes must be covered with wire netting. In winter, the open front should be covered with canvas, gunny sack or some kind of a matting or board which helps to keep the birds warm.

For Plains: For the plains an open-front type of house with a slightly sloping roof is recommended. The walls of the house consist of one-inch wire-mesh on the upper two-thirds and a wall or plain cement-asbestos sheet on the lower portion on the sides leaving the front completely open. The solid or cement-asbestos sheet wall on the three sides is intended to protect the birds from severe drafts. In areas which are not subject to severe drafts, all the four sides may consist of wire-mesh walls. The foundation for the walls should be at least one foot below the surface of the ground on which the house is constructed. If the walls consist of cement-asbestos sheets or only wire-mesh, they should be fixed a foot deep in a trench dug all round. This is to ward off the danger of rodents like rats and mongoose from gaining access to the house by burrowing from under the houses. During the cold winter months or in the rainy season the open walls should be covered with canvas or gunny cloth.

CHEAP HOUSES FOR VILLAGES

A framework of angle iron is considered ideal. Wood is the next best material, but in most areas, it is subject to attack and destruction by white ants. In such places either properly seasoned or preserved wood should be used or the wood work should be embedded in concrete, where it comes in contact with the ground, so that it is not attacked by white ants. This necessarily involves some initial outlay, which it may not be possible for all poultry keepers to incur. A cheap house which could be constructed easily by the poultry keeper himself, with the locally available materials and as economically as possible is, therefore, very necessary.

Cheap houses can be constructed using gunny cloth, split bamboo, twigs and branches of shrubs and trees, hay, and straw. A brief description of some of these houses is given below:

Gunny Cloth House. The most convenient size for a gunny cloth house is 8'×6'×6'. It is constructed by nailing gunny cloth on a wooden framework of suitable size. The cloth is then coated, once on the inside and twice on the outside, with cement-lime mixture. Depending on the region where housing is to be provided, the sides are covered either wholly or partially with gunny sack, the remaining area being covered with one-inch wire-mesh.

A half-inch wire-mesh is buried a foot deep all round the house below the ground level, with a margin of about a foot around the framework above the ground level to prevent predatory pests from burrowing into the house. The wooden supports which carry the house are liable to be destroyed by white ants and frequent wetting from rains. It would be economical if about one foot length of these supports, near the ground, could be made of angle iron or alternately if the lower portion of the supports is so fixed as to be replaceable as and when necessary.

The construction of this type of house is estimated to cost Rs. 25. It can accommodate from 12 to 15 birds.

Split Bamboo House. Bamboo is available in many regions and constitutes a cheap construction material for poultry houses. The house is constructed with split-bamboo sticks and either left open on all sides (Fig. 77) or covered partially on the sides, excepting the front, up to a height of 1'-6" from the bottom with mud plaster. Cow-dung and mud serves as good building material. Such a plastering will save the house from predatory animals. The roof may be thatched with hay. The house, measuring 8' x 6' x 7', would cost about Rs. 30 and would accommodate 12 to 15 birds.

House from Dried Twigs and Bamboos. A still cheaper house, costing about Rs. 3 can be made out of bamboo and dried twigs. The framework is constructed with dried twigs or grain stalks, they being held together either by thin binding wires or string. The corner supports of the house should rest on flat stone or brick slabs, as otherwise bamboo is readily attacked by white ants if it comes in direct contact with the ground.

Such a house, however, is not durable; and in vermin-infested areas it will abound in ticks, mites, and fleas, which it would be difficult to eliminate even with the help of insecticides.

POULTRY HOUSE EQUIPMENT

Fixtures which are necessary for the comfort of the birds and convenience of the poultry man constitute the poultry house equipment. The equipment has a wide variety of designs, but it should embody certain essential features, such as, convenience, portability, economy, comfort of birds, and durability.

Convenience relates mainly to the minimising of labour required in taking care of the birds, mostly in connection with feeding, sanitation and collection of eggs. Figure 80 illustrates defective arrangement and proper arrangement of the equipment, respectively. The latter leads to considerable saving of labour.

Portability is closely related to convenience and implies that all equipments are so installed as to facilitate easy removal of any component for cleaning and spraying the house.

The equipment should not be expensive and cumbersome. Consistent with efficiency, as little money as possible should be invested on the equipment. It is well to remember that ordinarily simple construction is economical.

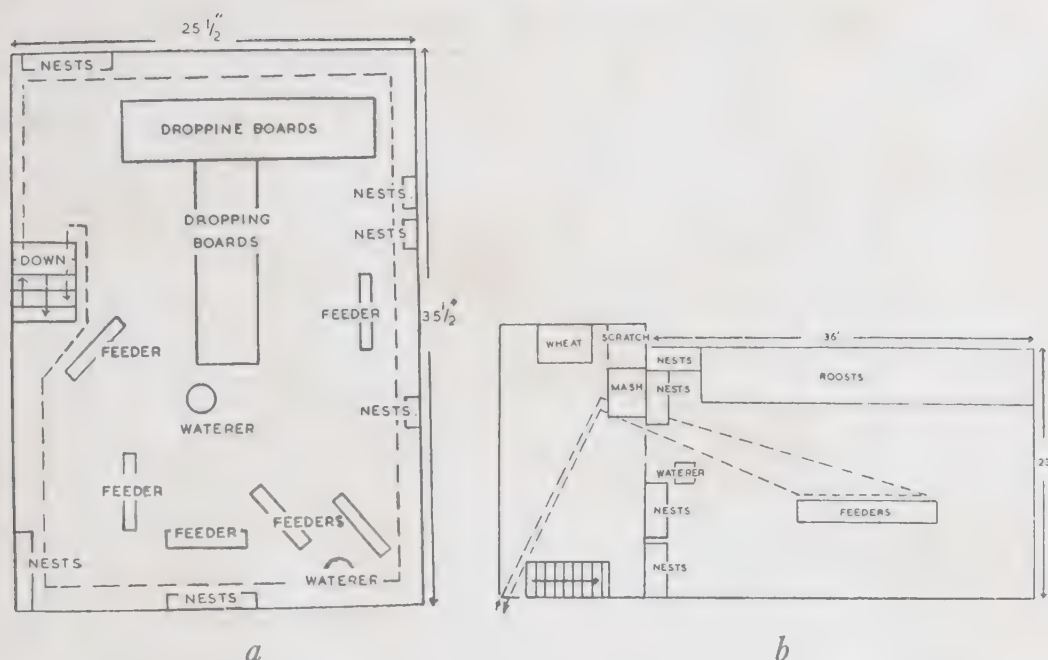


FIG. 80. ARRANGEMENT OF EQUIPMENT IN A POULTRY HOUSE: (a) DEFECTIVE ARRANGEMENT; (b) PROPER ARRANGEMENT

Comfort of the birds is the prime factor in securing satisfactory egg production, and should not, therefore, be neglected. Adequate perch and nest space, cleanliness of feed and water, ease of reaching the roosts and feed containers, all contribute to the comfort of the birds.

Durability or permanence of poultry fixtures and appliances should not be ignored while equipping poultry houses. Frequent cleaning which is essential requires a highly durable equipment.

Perches or Roosts. Perches or roosts are necessary in the poultry houses. Apart from catering to the natural instinct or desire of the chickens to get above the ground at night, perches help materially to keep the birds' feet and plumage clean. It is advisable to encourage birds to roost on perches from early age of six to eight weeks while they are still in their cold-brooding stage. This can be done by providing suitable perches at one end of the brooder room (Fig. 81). The perch space varies with the size of the breed; seven to nine inches of it for smaller breeds like the Leghorns, and nine to 12 inches for the general-purpose breeds are essential. A large number of birds can be accommodated on a perch if they are young, because of their smaller size, than the mature birds. More perch space is advisable in the hot season.

The perches should be big enough for the birds to rest comfortably. Wooden perches, two inches square, round at the top, and flat at the bottom can be used. These make roosting more comfortable and prevent sore feet. Wooden perches are mostly used but can be replaced by two inches thick split bamboos or other poles wherever available. As far as possible no nails should be used for fixing the perches, so that they can be easily removed for cleaning.

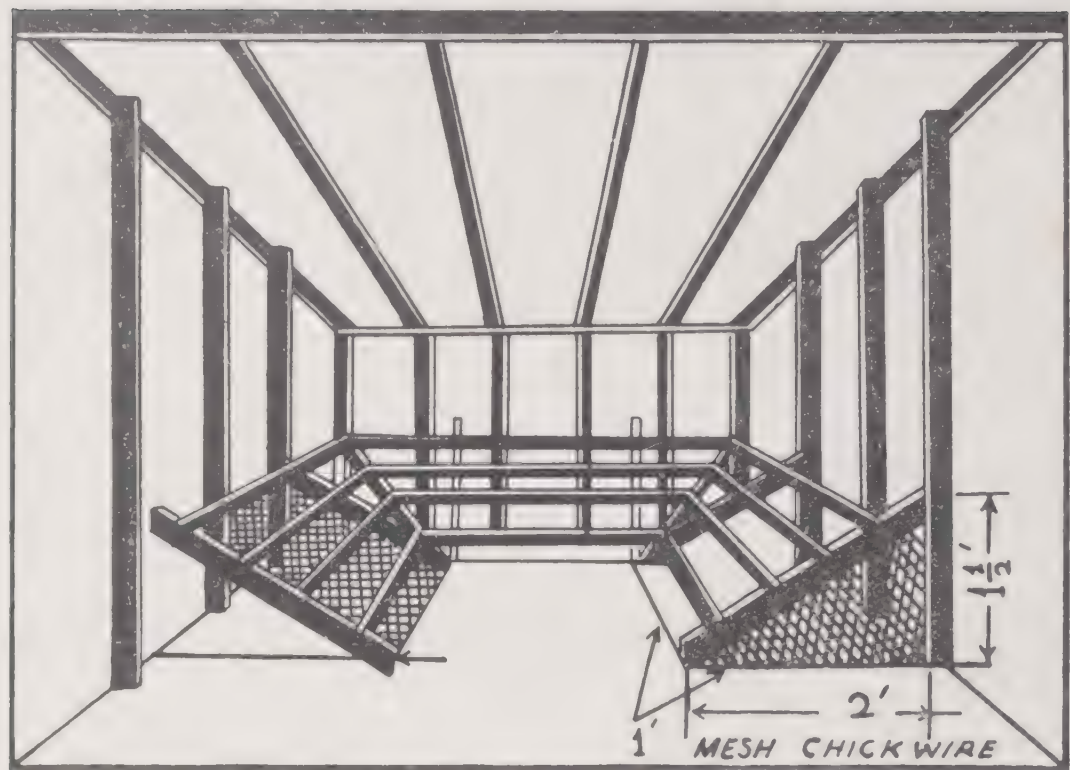


FIG. 81. SKETCH OF A BROODER ROOM WITH PERCHES

All perches should be of equal level, and placed at a distance of at least one foot from each other. The most convenient height at which roosts should be fixed is 18 inches. Chick-roosts generally encourage early roosting. Wire-netting prevents the chicks from crowding underneath the roosts and keeps them away from the droppings.

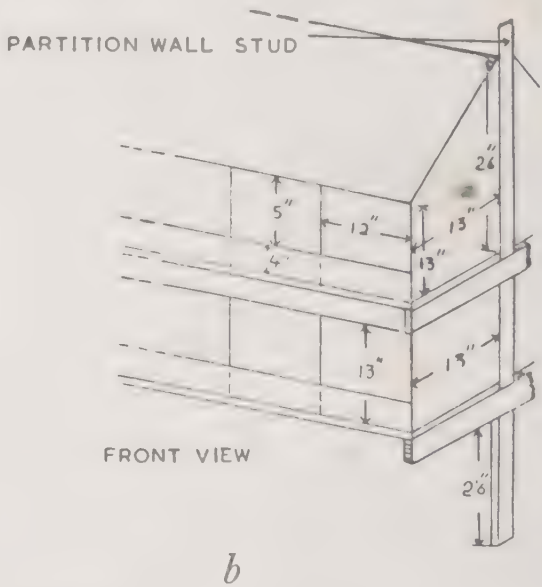
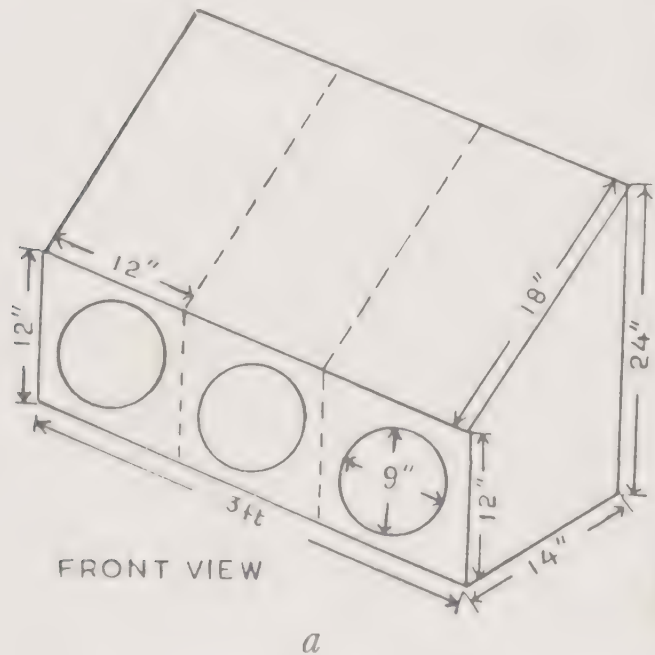


FIG. 82. TYPES OF NESTS: (a) SINGLE UNIT NEST; (b) NEST FOR A COMMERCIAL FARM

Nest Boxes. Each pen of laying birds should be provided with nest boxes for laying eggs (Figs. 82, 88). Hens seem to prefer nests that are not brightly lighted. Nests



FIG. 83. WATER FOUNTAIN MADE OF TIN



FIG. 84. EARTHEN WATERER



FIG. 85. BOTTLE AND BOWL WATER FOUNTAIN



FIG. 86. *Ghara* AND *Kunali*



FIG. 87. CHICKEN RUN

should be roomy and readily removable for cleaning or spraying against mite and tick infestation. Empty kerosene tins make excellent nest boxes and do not harbour lice, mites or ticks, if the litter is changed frequently. Any small wooden or packing case, about $1\frac{1}{2}$ feet square, or an earthen pot in which some wood shavings, dry grass or sand is placed will serve the same purpose. One nest-box for every four hens is the most desirable arrangement.

Nests or nest-boxes should be placed in or outside each pen of the laying houses, depending on the system of poultry keeping practised. The hen must be able to reach and enter the nest readily; and the poultry keeper should be able to gather the eggs with a minimum of effort.

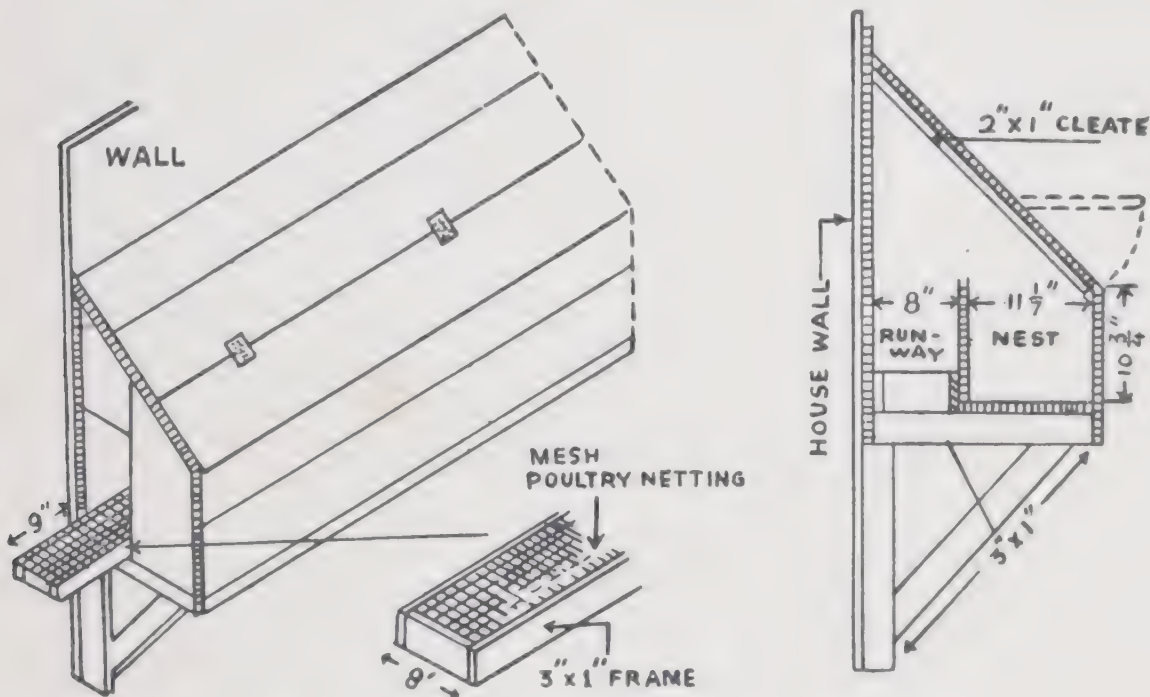


FIG. 88. TRAP NEST SHOWING CONSTRUCTION DETAILS

Trap Nests. Trap nests are essential when accurate recording of production of individual birds is desired. Such nests are simple to make, and any carpenter can build them. A working drawing for a trap nest is given in Fig. 89. There should be one trap nest for every three to four hens. Such trap nests can also be made in

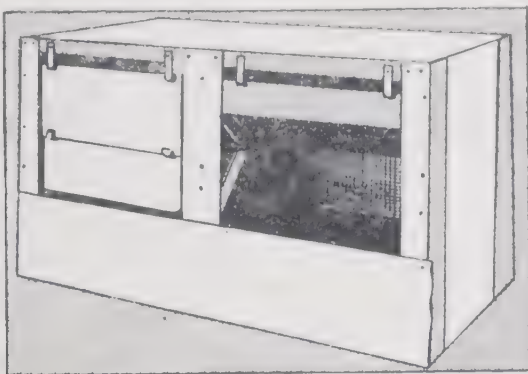


FIG. 89. SKETCH OF A COMMON NEST

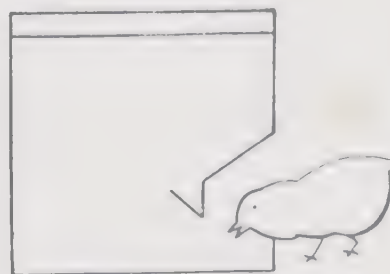


FIG. 90. A SIMPLE SELF-FEEDER FOR BABY CHICKS

units of 4, 5 or 6 placed under the poultry house or the scratch-shed in a cool, dark corner of the enclosure. In a colony house a series of such trap nests is most advantageously kept along the wall, preferably on a raised platform.

Feed Hoppers. Troughs, pots, and pans used for feeding should be of suitable size depending on the age and size of the birds. Vessels used for feeding should be so protected (by running wires cross-ways) as to prevent the birds from scratching out the feed.

The feeding of dry mash to chickens is now recognised as a desirable practice. The laying hens at least should have ready access to mash. There should be arrangement for keeping adequate supply of mash in such a way that it remains clean and is accessible to birds at all times with the minimum waste.

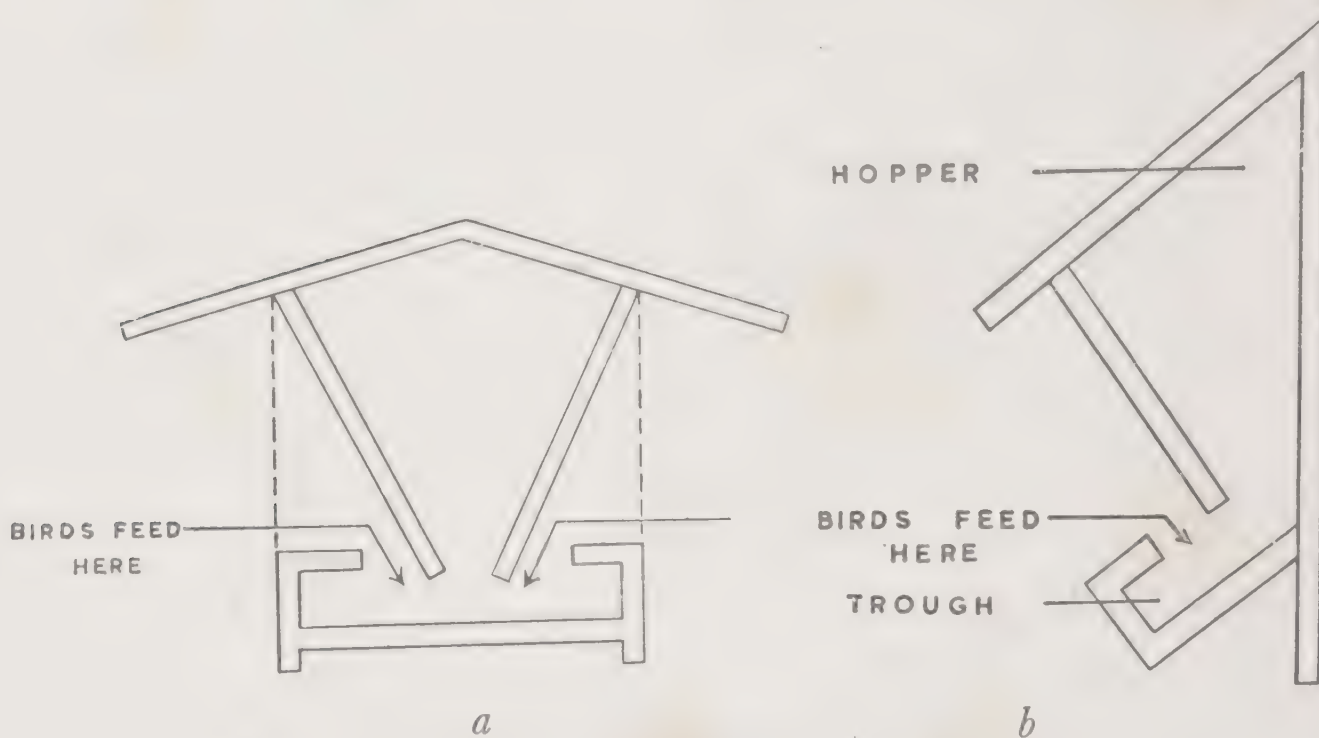


FIG. 91. SELF-FEEDERS: (a) DOUBLE-SIDED; (b) SINGLE-SIDED

A self-feeder is one in which fresh supply of grains or other dry food automatically falls from a hopper into a trough as the birds feed. All feeders should be big enough for two or three birds to feed easily at a time. Figure 90 gives the plan of a self-feeder especially suited for baby chicks. Such a feeder can be made from a large tin can with a lid. The can is cut along one side, a quarter of an inch from the bottom, and then half way up the two corners. The loose piece is bent inwards.

Figure 91a represents the cross-sections of self-feeders, made from wooden boards half an inch thick, which can be hung on a wall or made to stand on the ground. Three inches is a suitable height for the trough for growing birds.

Figure 91b is the cross-section of a double-sided self-feeder made from half inch thick boards. Six inches is a suitable height for the trough for the adult birds.

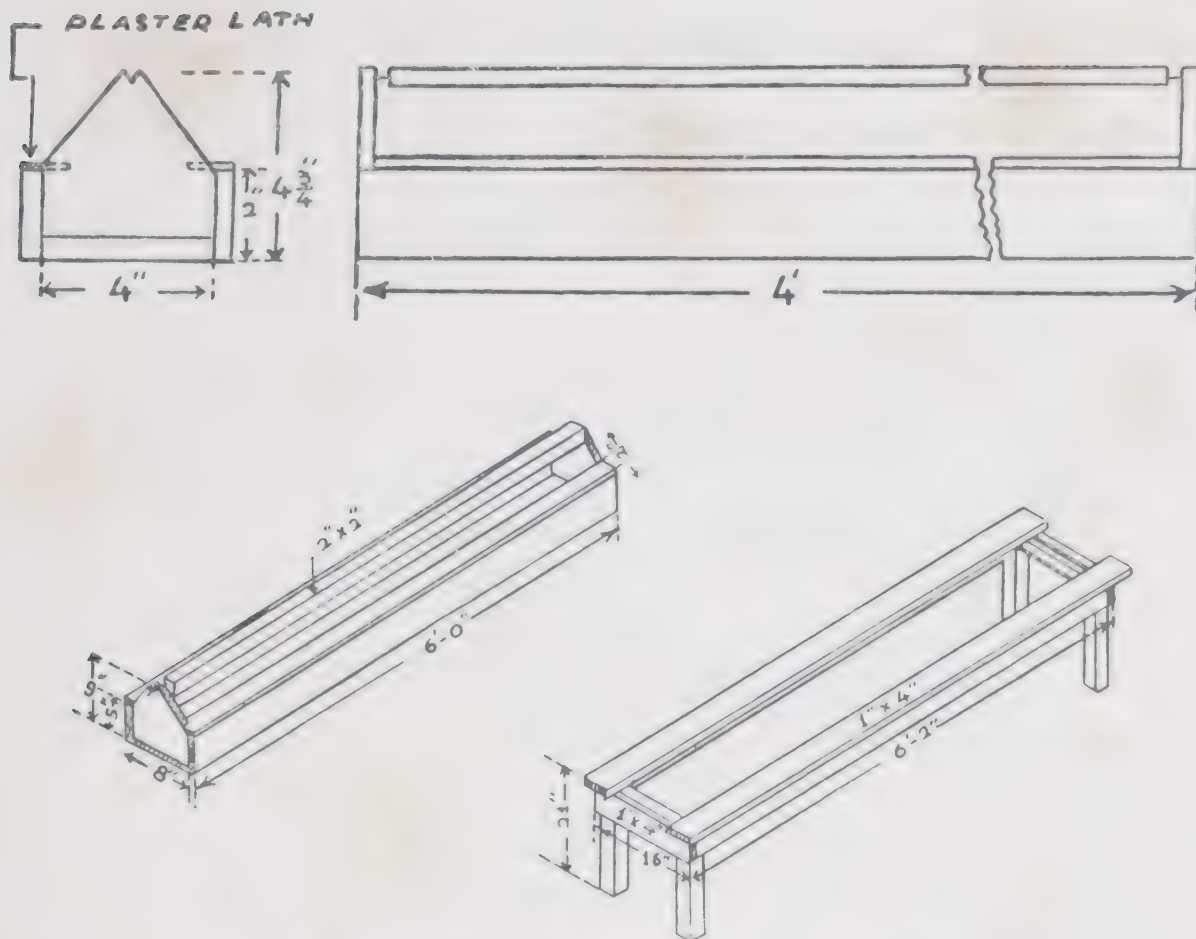


FIG. 92. FEED HOPPERS ON STAND FOR LAYING BIRDS

Besides the above, various types of open-trough feeders are in vogue (Figs. 78, 79, 92 to 94). They are simple to make. Their principal disadvantage lies in the fact that fresh mash has to be supplied frequently, and they have to be provided with a reel or balancedboard in order to keep the birds out of the mash and to prevent roosting on the hopper.

Very cheap and useful hoppers can be made by a village carpenter using thick bamboos wherever they are available. Poultry keeping is very popular in heavy rainfall areas which abound in bamboos. Provision of simple feeders made of bamboos as illustrated in Figure 94 offers great scope for popularising correct methods of feeding the birds.

It is more economical to use hoppers both sides of which may be used by birds in feeding. It is safe to estimate that one linear foot of hopper space will be required for every six or eight birds. This would mean that a flock of 100 birds would require a total length of eight to 10 feet of a two-sided hopper.

Watering Devices. Chicks require and consume large quantities of water, which should be made available to them at all times. The ideal watering device is one which is large enough for a full day's supply, keeps the water clean and cool, does not corrode on account of chemical action, does not rust or break easily, does not topple over readily, is easy to empty, clean and refill, does not allow the birds to get into it and spoil the water and is relatively inexpensive.

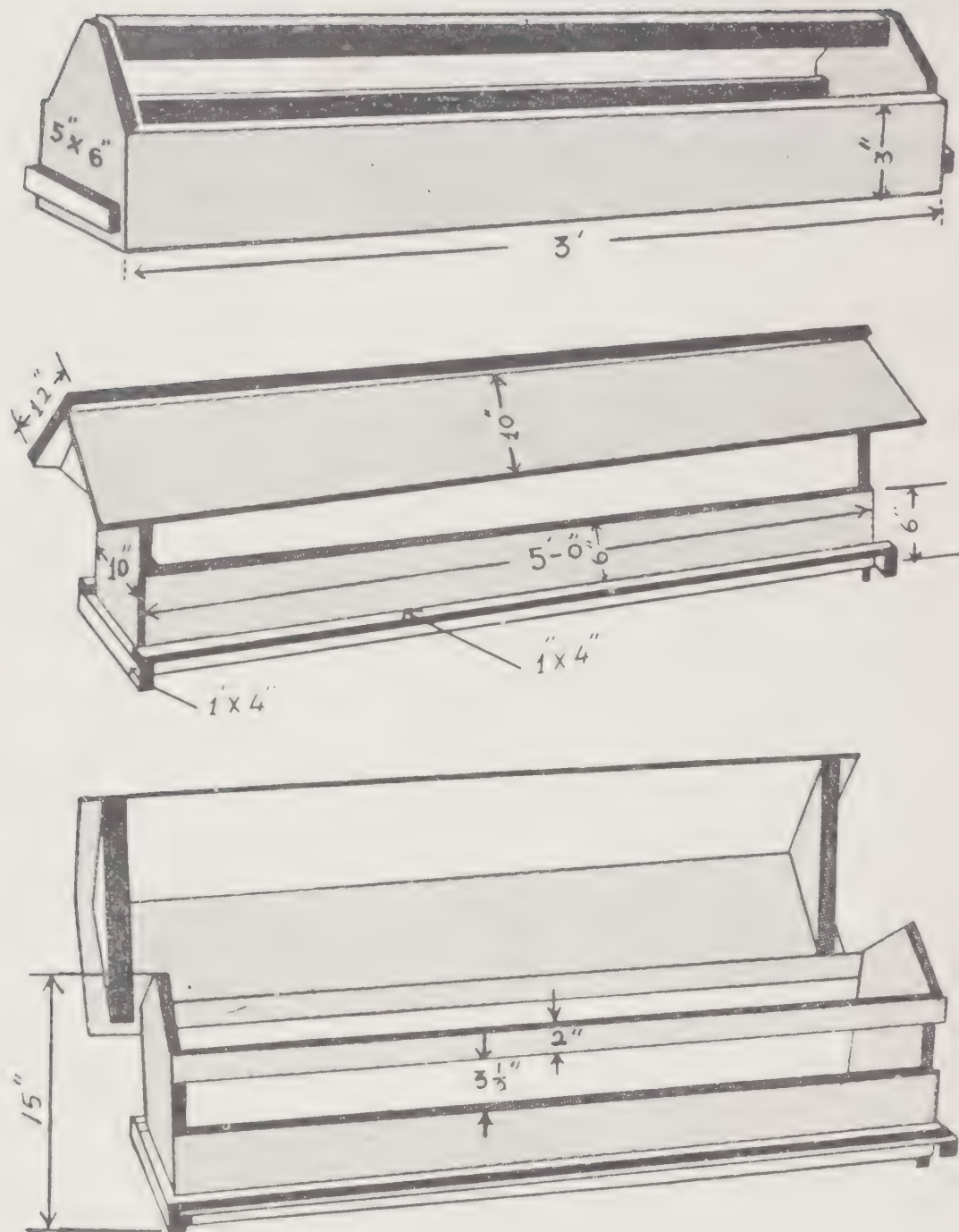


FIG. 93. CHICK FEEDERS

A wide variety of watering utensils satisfying the above needs can be had. These may be in the form of fountains or covered containers.

In a water fountain, the level of water in the feeder dish is kept always at the same level. This is done by arranging for a constant supply of fresh water to flow automatically from a container, as the level in the dish goes down. Some water fountain types are explained in the following pages.

(1) By far the simplest fountain (Fig. 95) consists of an empty cigarette tin or mud pot with a hole made in its side, about half an inch from the top. It is filled with water, then covered with a somewhat deep saucer and turned upside down. The water pours into the saucer through the hole, but cannot rise above

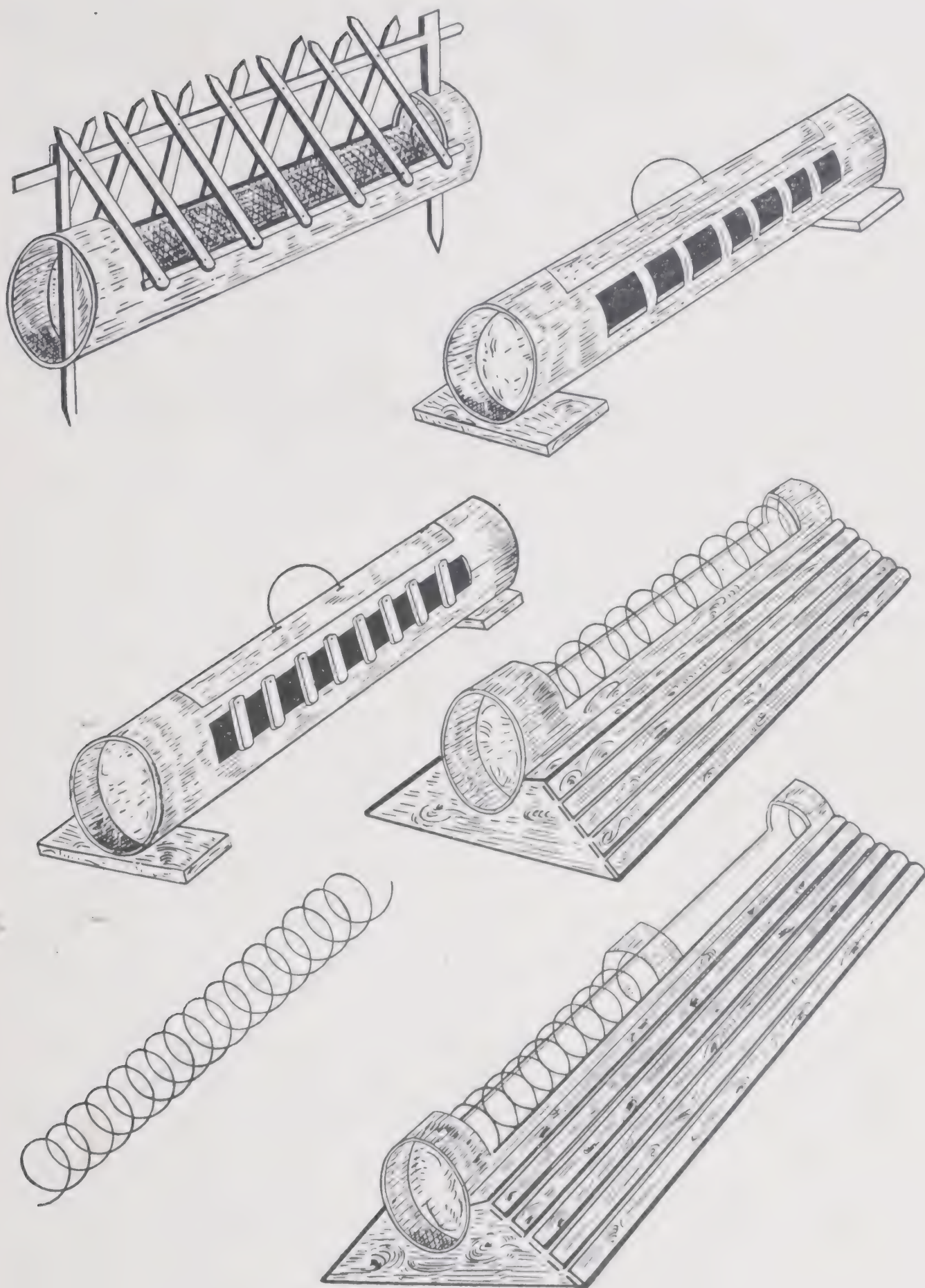


FIG. 94. BAMBOO FEED HOPPERS

the level of the hole and does not flow over the edge of the saucer. This is suitable for the chicks. Figure 83 shows a bigger fountain made of tin on the same principle.

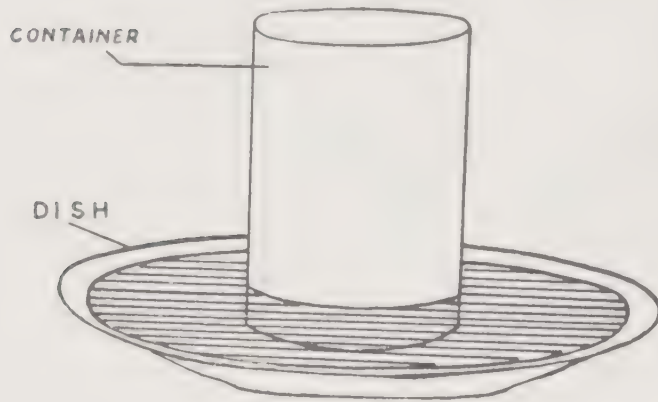


FIG. 95. SIMPLE WATER FOUNTAIN

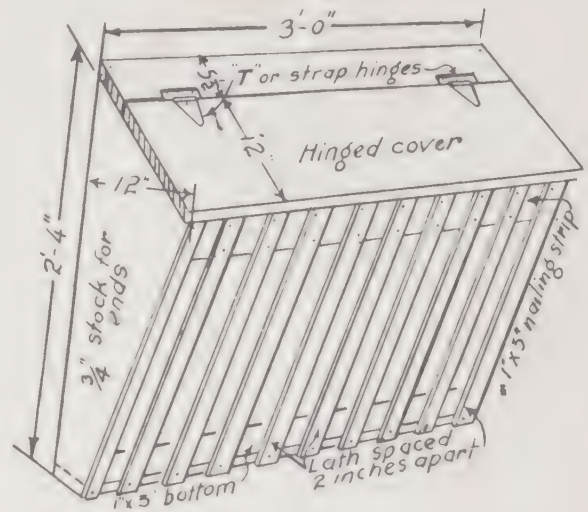


FIG. 96. GREEN FEED WALL RACK

(2) A bottle filled with water is turned upside down over a bowl full of water. The bottle is supported on nails against a stand, post or a tree so that the end of the neck is just below the top of the water in the bowl (Fig. 85). The water in the bowl is always level with the neck of the bottle.

(3) A cheap and efficient water fountain similar in principle to (1) above but suitable for adult birds in large pens can be made by using two earthen vessels shaped like a pot and bowl (*ghara* and *kunali*) respectively (Fig. 86). The *ghara* with a hole in the neck is filled with water and then inverted in the *kunali*. The water comes out of the small hole in the *ghara* and keeps its level without overflowing the sides of the *kunali*. One such fountain will be enough for a pen of 10 birds for the whole day, and several such fountains if placed in bigger pens will save the labour of filling the vessel again and again.

Cheap and hygienic waterers can also be made out of earthen wares (Fig. 84) by any village potter.

Grit and Shell Containers. Shell and grit have to be provided to poultry separately as these are not included in the feed mixtures. Ordinary wall hoppers made either of wood or metal serve the purpose.

Green Feed Racks. A green feed wall rack (Fig. 96) is desirable, as throwing such feed in the litter is insanitary. The racks are made of slats or wire-mesh and hung at some height to provide exercise to the birds as they strive for the feed.

Runs. Confined birds need as large a run as can be afforded. If more than one breed is kept, it will be necessary to enclose each breed within a fence in order to prevent mixing. An ideal run can be had by putting up a wire-mesh fence, $\frac{1}{2}$ " mesh being necessary for the chicks and $1\frac{1}{2}$ "-2" mesh for adult birds. A six-foot wide roll of wire-mesh or two rolls of three-feet wide mesh joined together at the centre by a binding wire and mounted on wooden poles makes ideal fencing.

It is advisable to fix the lower edge of the wire-mesh at least six inches under the surface of the ground in a trench to provide protection against predatory animals. The chicken-run should be covered by wire-mesh also on the top to prevent crows, hawks, and kites from carrying away the young chicks (Fig. 97). In the absence of wire-mesh, the use of split bamboos or *sarkanda* is recommended for the runs. They are not quite so durable, but serve the purpose.

The idea of providing each pen of birds with two runs has much to recommend it. The birds can be allowed into one of these for a few months, and then changed to the other. This gives the runs 'rest', allows the weather and the sun to clean these, and enables the grass to grow again. In reality, this system is one of mere rotation. The run which is in disuse as a result of shifting the birds to the other can be ploughed, and a crop of cereals or berseem raised without using any manure. When the crop is mature it is harvested, the fowls are turned in from the alternate run, which is similarly treated. The system makes for additional income and ensures better health for the poultry at the same time.

Laying Batteries. The system of using batteries for laying hens is a comparatively recent one and is one of the developments of battery brooding. Each hen is housed in an individual all metal cage or compartment about 12 to 16 inches wide, 18 inches long and 18 inches high. The wire floor gently slopes forward so that the egg, when laid, rolls underneath the feed trough and gets out of reach of the hen. The cages are contiguous and may be single rows (single deck) (Fig. 97) or built in tiers to accommodate any number of layers (Fig. 98).

The system is unknown in India at present. It is, however, well-adapted to localities in or near large cities where the land in adequate extents is either unobtainable or unsuitable for setting up the usual plant. In such locations, it is possible to make use of any empty building for this purpose. The system also admits of utilising marshy and damp areas highly unsuitable for poultry rearing by the usual methods. Cities like Bombay and Calcutta where similar wet conditions prevail during a good part of the year can take to poultry farming intensively by keeping the birds in battery cages.

The advantages claimed for the system of keeping poultry in laying cages are:

1. Positive and prompt culling is possible.
2. Culls can be put into the market in better condition since they can be spotted before they lose weight.
3. Somewhat higher egg production per bird since each hen has constant access to feed and water.
4. Feed consumption per dozen eggs is somewhat less since the hen wastes less energy in exercise and possibly lays more.
5. Elimination of cannibalism.
6. About one-third less floor space is required for layers in batteries.
7. Both Leghorns and heavier breeds respond favourably in laying batteries.
8. Plants can be set up regardless of soil and climatic conditions.

9. Continuous full use of equipment is possible since replacement of pullets can refill the empty cages as soon as culls are removed. This refilling of empty capacity is impractical with birds on the floor.

The disadvantages inherent to the system are:

1. Higher initial investment per bird on the cages, although it eliminates the necessity of buying feeders, waterers, nests or building perches which are necessary for birds on the floor.
2. Greater skill and care in feeding are required for layers in batteries although the nutrition requirements for layers in cages are much the same as for those in floor pens, except for vitamin D and fibre requirements, which are generally greater for layers in batteries.
3. Labour requirements for feeding and watering layers in batteries are considerably greater than for floor pens equipped with labour saving equipment.
4. The battery operator to be successful must be more alert as a caretaker and as a businessman than would be necessary for managing hens under floor conditions.
5. Economical operation of the battery necessitates starting a new brood of chicks for replacement of pullets at least four to six times a year.



FIG. 97. LAYING BATTERY (ALL METAL)

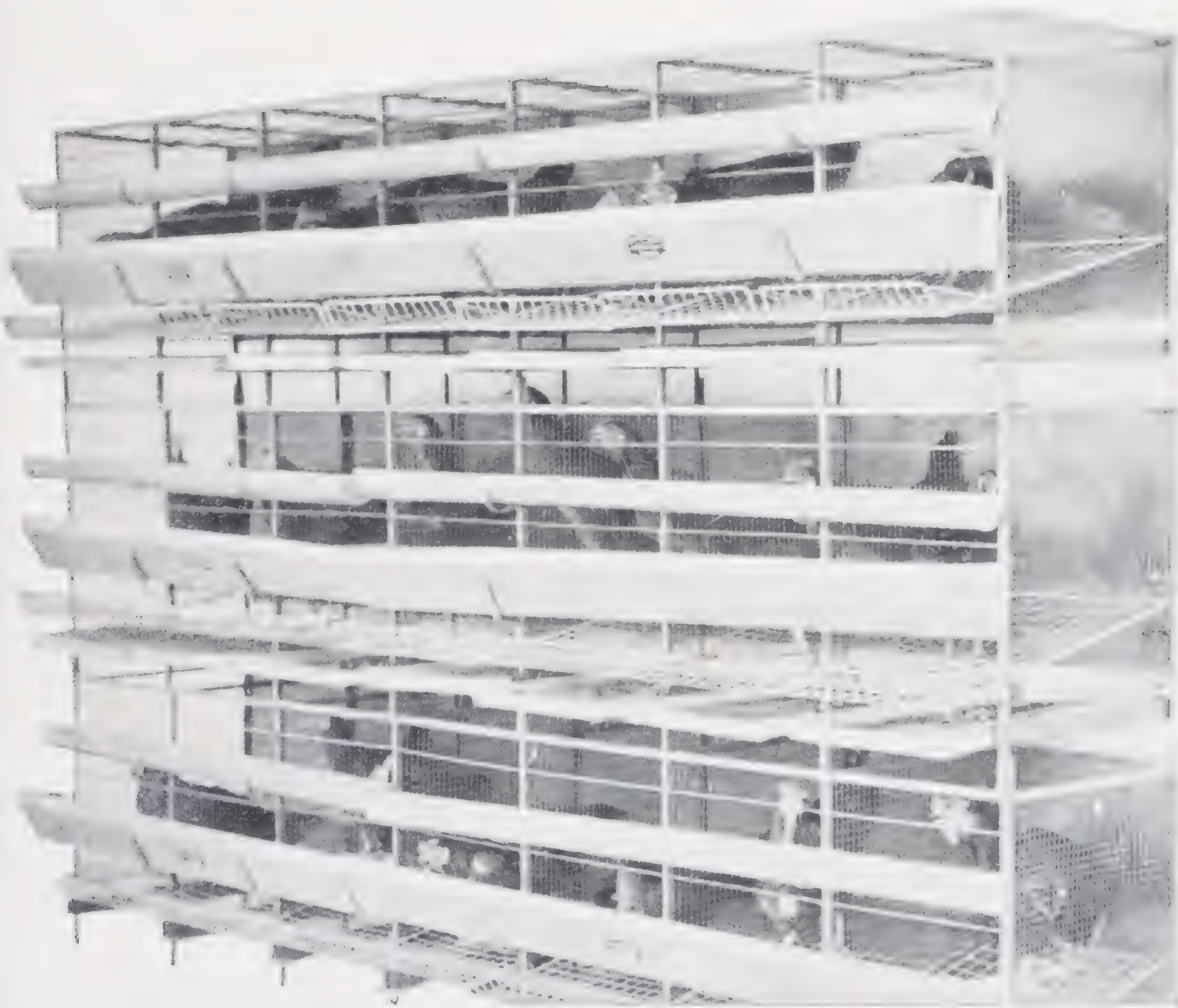


FIG. 98. LAYING BATTERY FOR 21 BIRDS IN THREE TIERS



FIG. 99. TERMITE (WHITE-ANT) COMBS
BEING DUG OUT FROM ANT-HILLS



FIG. 100. TERMITES BEING FED TO
GROWING CHICKENS



FIG. 101. FEEDING THE CHICKS IN THE BROODERS

FEEDING PRINCIPLES AND PRACTICES

IN any scheme which aims at improving the poultry stock the question of nutrition for balanced feeding must receive considerable forethought. Growth as well as egg production are influenced by the quality and quantity of the feed consumed. Feed of poor quality, apart from not being digested readily and turned to good account, causes ill-health, lowers vitality, retards development and diminishes egg-yield. It has been observed that the common village or *desi* birds, with an average laying capacity of about 50 eggs per annum, can lay more than double the number of eggs when properly fed. This fact deserves special attention in the context of increasing the egg production in the country, for the bulk of our poultry consists of the mongrel type of *desi* birds, the improved breeds constituting only 1.4 per cent of the total.

The digestive system of chickens has its own peculiar needs; and the birds appear perpetually hungry, always looking around for something to eat. They should, therefore, be fed adequately. The science of nutrition has helped in evolving proper feed mixtures, but giving these to the birds in the right way is an art by itself.

The value of a poultry feed depends largely on the kind and relative amounts of different nutrients it contains, which in their turn need to be adjusted to the requirements of the purpose for which chickens are kept. A feed intended for promoting rapid growth differs in some respects from a diet meant for fattening the birds for table purposes. Similarly, the feed required for production of eggs is different.

The problem of preparing a good feed has a number of aspects that need careful study. There is no single best method of feeding. Certain nutritional requirements must be met and for this several factors, such as relative cost of different feeds, their food value, local availability, etc. must be taken into account.

NUTRIENTS AND THEIR FUNCTIONS

The essential nutrients which should be contained in poultry feeds are: water, carbohydrates, proteins, minerals and vitamins. These constituents are the same as found in the fowl's body and in the egg (Fig. 102). Each serves a

particular purpose. Tables 14 and 15 give the functions of these nutrients and indicate the symptoms which their deficiency gives rise to.

Water. Water plays a highly important part in maintaining health and promoting growth, fleshing and egg production. Among its most important functions are its role in the digestion and assimilation of nutrients, regulation of body temperature, elimination of waste products, etc. Chickens can live longer without food than without water. It is, therefore, important that birds should have continuous supply of clean drinking water.

Table 14. NUTRIENTS, (EXCEPT VITAMINS) REQUIRED BY CHICKENS

Nutrients	Important Functions	Deficiency Symptoms
Water	Softens feed, aids in the processes of digestion and absorption of other feeds. Helps to regulate body temperature. Assists in the elimination of waste products.	Retarded growth. Decreased egg production. Loss of body weight and death, if water is withheld for a considerable period.
Carbohydrates	Source of energy for maintaining body temperature and for all bodily activities and for growth and egg production.	Retarded growth. Decreased egg production. Loss of body weight.
Fats	Source of energy to a limited extent only. Sometimes deposited in body.	There are practically no fat-deficiency symptoms.
Proteins	Growth. Repair of body tissue. Egg production.	Retarded growth. Decreased egg production. Loss of body weight.
Calcium	Formation of bone and egg shell. Heart rhythm. Muscle tone. Blood clotting.	Retarded growth. Soft bones. Decreased egg production and hatchability. Thin shells.
Phosphorus	Bone development. Egg production. Utilization of carbohydrates.	Retarded growth. Soft bones. Decreased egg production.
Manganese	Utilization of phosphorus.	Slipped tendon or perosis. Decreased hatchability and abnormal embryos.

Other minerals required by chickens include iron, copper, magnesium, potassium, sodium, chlorine, iodine and sulphur. Practically all these minerals are present in sufficient quantities in normal diets, except sometimes sodium and chlorine, which are supplied by adding salt to the diet.

Table 15. VITAMINS REQUIRED BY CHICKENS

Vitamins	Important Functions	Deficiency Symptoms
A (anti-ophthalmic)	Preserves health of eyes, nervous tissue, and lining of respiratory organs. Promotes growth.	Retarded growth. Nutritional roup. Bleached beak and shanks. Kidney and nerve degeneration. Staggering gait.
B ₁ (thiamin)	Maintains appetite. Preserves health of nervous tissue. Prevents polyneuritis.	Retarded growth. Emaciation. Retraction of head.

Table 15—(Concluded.)

Vitamins	Important Functions	Deficiency Symptoms
B ₆	Maintains appetite. Promotes growth. Prevents convulsions.	Retarded growth. Convulsions.
D (anti-rachitic)	Utilizes calcium and phosphorus. Forms bone and egg-shell.	Retarded growth. Rickets. Soft-shelled eggs. Decreased egg production and hatchability.
E (anti-sterility)	Maintains normal brain structure and preserves health of reproductive organs.	'Crazy-chick' disease (nutritional encephelomalacia). Loss of fertility in males. Decreased hatchability.
H (biotin)	Promotes growth.	Incrustations on bottom of feet.
K	Enables blood to clot normally.	Haemorrhages.
Riboflavin	Promotes growth. Increases hatchability. Preserves health of peripheral nerves.	Retarded growth. Decreased hatchability. "Curled-toe" paralysis.
Pantothenic acid (anti-dermatosis)	Preserves healthy skin.	Incrustations of corners of mouth and on the upper surface of the feet.
Anti-gizzard erosion factor	Preserves normal health of lining of gizzard.	Erosion of ulcers on lining of gizzard.
Choline	Necessary for bone development and egg production. Prevents perosis.	Perosis or slipped tendon.

Carbohydrates. Carbohydrates constitute the bulk of the poultry feed. The grains and their by-products, which constitute from 75 to 85 per cent of the bird's ration are their principal sources. They provide heat and energy.

Fats. Fats serve as an additional source of heat and energy for the chickens, having about 2.25 times the heat producing value of carbohydrates. But the bird has apparently little need for fats because these are not utilised readily. The fat content of the body as well as of the egg is obtained largely from the carbohydrates portion of the diet.

Proteins. Proteins are regarded as tissue and body builders, and are very essential for the growth of the chicken and production of eggs. A live chicken has approximately 21 per cent protein, and an egg about 13 per cent (Fig. 102). Proteins constitute from 15 to 20 per cent of the poultry ration, depending on the purpose to which the ration caters. The National Research Council of the United States stipulates the protein requirements of poultry as: Starting—20 per cent; growing—16 per cent; laying—15 per cent; and breeding—15 per cent.

The proteins of cereal grains which constitute the bulk of a chicken's diet are usually deficient in what is termed 'the animal protein factor' (A.P.F.) which is essential for growth, production and hatchability of eggs. For this reason, feeds of animal origin have to be included in the usual feeds because they contain the animal protein factor.

Pullets usually start laying before they attain their full body size. During this time they require protein for growth as well as for egg production. A 15 or 16 per cent protein diet is essential to sustain egg production at a high rate, provided the proteins are of good quality. This is ensured by the use of animal protein supplements such as milk products, meat scrap and fish meal to the extent of about 25 per cent or more of the total protein content of the feed.

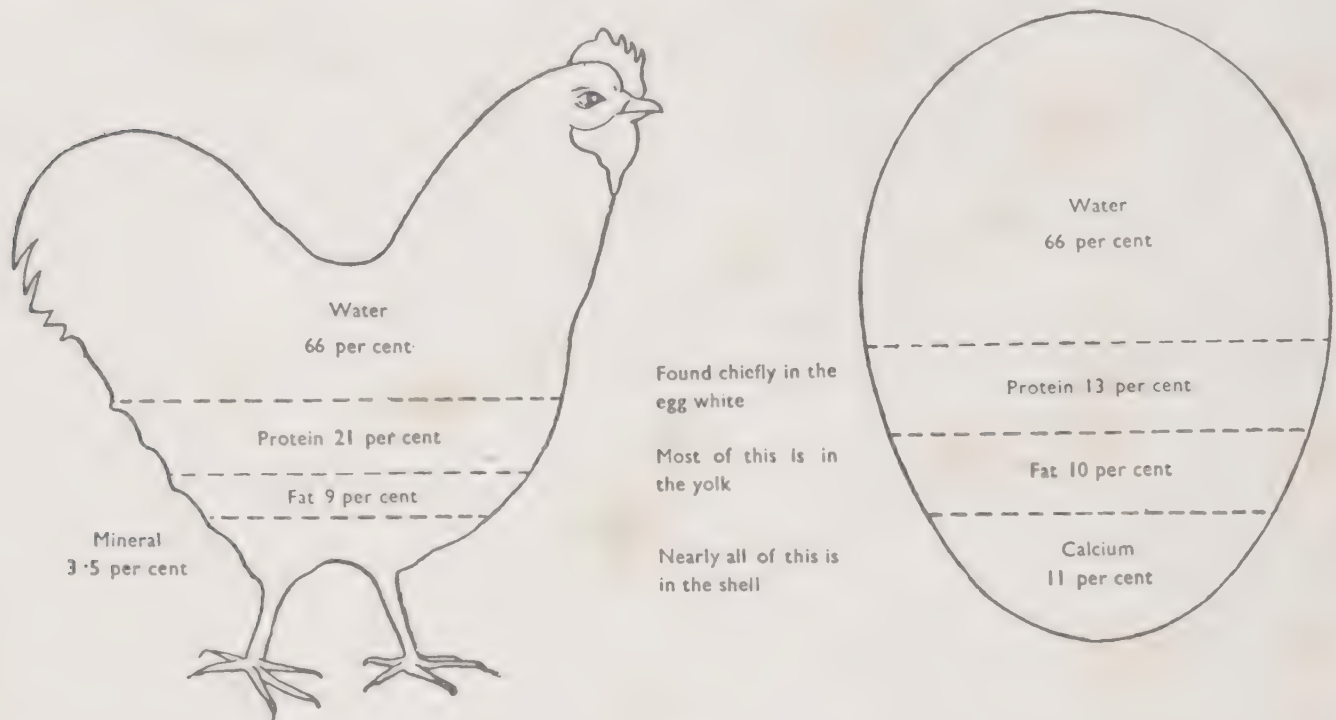


FIG. 102. APPROXIMATE COMPOSITION OF THE CHICKEN'S BODY AND THE EGG (*From Poultry Farming Education Manual, U.S.A.*)

Minerals. Minerals constitute about 3 to 4 per cent of the live-weight of the chicken, and over 10 per cent of the weight of the egg. These are essential for the development of bones and other tissues, and for the formation of egg-shell as also for the utilization of other nutrients efficiently.

The minerals required are: calcium, phosphorus, sodium, chlorine, iron, copper, manganese, magnesium, potassium, iodine and sulphur. For the most part these are contained in adequate amounts in normal diets except perhaps manganese.

It is necessary to provide calcium and phosphorus in the ratio of about 2.5 to 1 for laying birds. As regards sodium and chlorine, an all-mash feed should consist of 0.5 per cent common salt while the mash portion of a mash-cum-grain feed should contain 1 per cent salt.

A simple, cheap and satisfactory mineral mixture consists of the following:

Bonemeal	..	..	..	..	40 parts
Oyster shell or limestone (ground)	..	..	..	..	40 parts
Salt	..	..	..	..	20 parts
Total	..	..	..	..	100 parts

A more complete and efficient mineral mixture consists of the following:

Bonemeal	..	..	..	..	27.97 parts
Oyster shell or limestone (ground)				..	50.00 parts
Salt	..	..	..	..	20.00 parts
Ferrous sulphate		..	..	..	2.00 parts
Potassium iodide		..	..	..	0.02 part
Copper sulphate		..	..	..	0.01 part
Total	..	..	..	..	100.00 parts

The mineral mixture is generally used to the extent of 5 per cent in the poultry ration.

Vitamins. Vitamins are chemical substances which are present in feeds in small amounts and yet produce striking effects on growth, production, reproduction and maintenance of health. They are also called accessory food factors whose presence in the feed promotes efficient utilization of other nutrients.

As many as 10 vitamins are known to be essential for poultry nutrition. Under ordinary farm conditions where the chickens have access to green pasture and direct sunshine, vitamins are no problem. Under other conditions they will have to be supplemented. Although vitamins are required only in small quantities, and most of them are probably present in sufficient quantities in normal diets, under certain circumstances, some of these are likely to be deficient leading to unsatisfactory growth, production and even disease and mortality. Special care must be taken to see that they are supplied in sufficient amounts. Table 16 gives the various vitamins required, their important functions, and symptoms resulting from their deficiencies in the poultry feeds.

Antibiotics. Of recent development in the field of poultry feeding is the inclusion of antibiotics in the diet, which seem to stimulate the growth of young chicks. The increase in the rate of growth of the chickens depends on the all round adequacy of the diet and on whether the chicks are reared in previously used or unused quarters. Antibiotics have no effect when chicks are grown in previously unused quarters. Pure antibiotics are expensive, and it is not necessary to use them in pure state. Their by-products, besides being cheaper, serve the same purpose. Antibiotics in poultry feeds also appear to reduce the mortality rate. The most commonly recommended antibiotic is the by-product of Aureomycin sold under the name of 'Aurofac'.

BALANCING THE FEED

A balanced feed is one that contains the various nutrients in proper proportions so as to permit their efficient utilization in promoting growth or producing eggs. Efficiency in the utilization of feeds is of paramount importance in raising chickens or keeping layers economically. Unless the feed contains the nutrients in right proportion, some of it is likely to be wasted resulting in malnutrition.

Special attention is necessary in regard to protein, minerals and vitamins, demands for which increase with the growth of the birds. But if a diet is properly balanced with respect to these nutrients for the early growth period, it serves equally well for later growth, except for the percentage of proteins.

Table 16. NUTRITIVE REQUIREMENTS OF CHICKENS

Nutrients	Growing Stock	Laying Stock	Breeding Stock
1. Protein	1- 6 weeks 18-20 per cent 6-12 „ 16-20 per cent 12 „ 14-16 per cent	14.0-16 per cent	14.0-16 per cent
2. Minerals			
Calcium	1.5 per cent	2.0 per cent	2.0 per cent
Phosphorus	0.8 per cent	1.0 per cent	1.0 per cent
Sodium chloride	0.5 per cent	0.5 per cent	0.5 per cent
Manganese	50 P.P.M.	50 P.P.M.	50 P.P.M.
3. Vitamins			
A-International feed units per lb. of feed	1,500	3,000	4,500
D-International feed units per lb. of feed	180	360	540
Riboflavin (Vitamin) Micrograms per lb. of feed.	1,200	675	1,200
(All other vitamins are adequately supplied by cereals and cereal products commonly used in poultry rations.)			
4. Fats	Adequately supplied by feedstuffs commonly used in practical poultry rations. Poultry cannot utilise efficiently more than 5-7 per cent of the fat content in the feed.		
5. Water	Fresh clean water should be kept before the birds at all times.		
6. Fibre	Poultry cannot utilise efficiently more than 6-7 per cent of the fibre, bulky foods and roughage.		

Growing chickens need more protein and relatively less calcium and phosphorus in the feed than laying hens, but the proportion of phosphorus to calcium should be higher in the diet for the growing chickens than for laying hens. Laying hens require more of vitamins A and D, but less of riboflavin than growing

chickens. Birds kept in confinement without access to sunlight, as in the batteries, require more vitamin D than birds that have access to the range. Breeding stock meant for the production of hatching eggs requires more vitamin D and riboflavin than layers meant for the production of table birds or market eggs.

Table 16 gives the nutritional requirements of the birds in respect of the various constituents for different age groups.

Requirements of various vitamins both in quantity and quality are much larger in the case of poultry than in the case of larger animals, as the birds cannot synthesise much of the vitamin B complex group.

Of the minerals, calcium is much more important for poultry than for other animals, because it is not only required for bone formation but also forms 98 per cent of the egg-shell. Therefore, liberal supply of calcium is essential for proper growth, bone formation and egg production.

Many feeds serve as a source of more than one kind of nutrient. Grains and their by-products, for instance, serve primarily as suppliers of energy, but they also provide protein, some minerals and vitamins. Milk is a good source of protein and is also relatively rich in vitamins.

Table 17 gives the composition of various feedstuffs used for feeding poultry in the country. It will be handy in computing balanced feeds.

POULTRY RATIONS

Having dealt with the principles underlying the feeding of poultry, we come to the practical aspects of feeding. A poultry ration consists of several distinct parts recognised on the basis of character, purpose, condition of the feed, and the manner in which it is fed. The following parts may, therefore, be distinguished for practical purposes: (1) whole grains; (2) mashes; (3) green or succulent feeds; (4) liquids; (5) minerals; and (6) grit.

Grains. Grains provide the bulk of carbohydrates and fats needed by the poultry. A variety of grains either cracked or whole is fed. It is desirable that the grain feed should be made up of at least two or three different types of grains. From the point of view of economy, locally available grains (preferably home-grown) should be used in preference to imported grains. In rice growing areas, rice should be the staple feed. Corn or maize, wheat and oats are the cereals generally available in the North, and make excellent grain mixtures. Barley is also available in certain areas in the North. These grains are scanty in the South and the East and are, therefore, more expensive to feed.

The millets such as *jowar*, *bajra*, *sama*, and *ragi* are generally available in the southern and eastern regions. Although they are less easily digested than the cereals because of the harder outer husk, they can be fed along with rice or other locally available cereals. They are best used either cracked or ground. *Ragi* is best fed soaked overnight in water. Mixed with broken rice it makes a good grain feed.

Kinds and amounts of grains to be included in the grain mixture depend on several factors such as availability and cost of various grains, the season of the

Table 17. AVERAGE COMPOSITION OF FEEDS USED IN POULTRY FEEDING

No.	Feeding-Staff	Total Dry Matter per cent	Protein per cent	Fat per cent	Crude Fibre per cent	N-free Extract per cent	Mineral Matter per cent	Calcium per cent	Phosphorus per cent	Total Digestible Nutrients per cent
1.	Bajra ..	90.0	9.8	4.6	10.0	72.6	3.0	0.14	0.93	54.3
2.	Barley ..	91.9	9.3	2.7	6.2	71.1	2.5	0.23	0.78	70.8
3.	Blood meal ..	91.2	92.2	1.2	1.3	2.7	3.3	0.33	0.26	75.9
4.	Bonemeal ..	96.4	7.1	3.3	0.8	3.9	81.3	32.61	15.17	..
5.	Brewer's grain ..	92.8	25.6	6.7	14.8	42.0	3.7	0.25	0.47	65.3
6.	Buttermilk ..	9.4	3.5	0.6	..	4.5	0.8	0.18	0.10	9.1
7.	Fish meal ..	92.3	58.7	7.9	0.9	4.1	20.7	7.52	6.82	67.6
8.	Garbage ..	39.3	6.0	7.2	1.1	22.2	2.8	..	..	34.6
9.	Gram ..	91.9	18.0	4.5	6.9	60.1	2.4	0.40	0.90	79.0
10.	Groundnut cake ..	93.8	37.6	6.1	15.2	29.5	5.4	0.21	0.99	79.1
11.	Jowar or sorghum ..	90.4	13.8	2.3	..	71.9	2.5	0.11	0.77	73.7
12.	Linseed cake ..	94.4	28.9	4.2	9.1	42.8	9.4	0.69	1.62	82.6
13.	Maize ..	91.9	9.7	3.0	2.0	75.5	1.7	0.06	0.84	70.5
14.	Maize gluten ..	90.5	26.4	2.4	7.1	48.4	6.1	0.20	1.26	77.4
15.	Meat scraps ..	93.7	55.0	10.7	2.2	1.2	24.1	12.18	9.85	73.8
16.	Molasses cane ..	75.4	0.7	..	..	70.1	4.6	0.90	0.10	69.5
17.	Oats ..	90.5	8.7	6.0	..	71.0	5.4	0.28	0.73	71.7
18.	Peas ..	90.5	23.8	1.2	6.2	56.2	3.1	0.10	0.92	79.6
19.	Rice ..	87.5	8.3	1.8	8.8	64.7	5.0	..	0.48	59.1
20.	Rice bran ..	87.5	12.3	17.6	12.3	31.4	13.9	0.19	5.45	62.9
21.	Skimmed milk ..	9.6	3.7	0.1	..	5.0	0.8	0.22	0.27	8.6
22.	Soyabean meal ..	91.7	44.5	3.7	3.6	30.3	5.7	0.39	1.51	82.2
23.	Sunflower seed ..	63.3	18.0	25.7	28.1	14.2	7.3	0.50	1.26	89.2
24.	Wheat ..	91.5	9.6	1.7	1.7	76.8	1.7	0.19	0.70	84.0
25.	Wheat <i>manni</i> ..	94.3	11.9	5.1	11.4	51.0	14.9	0.30	0.97	34.0
26.	Wheat bran ..	89.0	11.5	4.4	12.2	54.1	6.8	0.23	2.00	70.8

year, the birds to be fed, the climate, and the character of the mash feed used.

Mash Feeds. Mash feeds are meant to supplement grain feeds in respect of proteins. Generally, they consist of a mixture of ground grains, grain by-products such as brans, shorts and middlings, oil cakes, minerals, and animal by-products. The mashes are fed to the birds in suitable troughs or hoppers.

Mashes are by far the most important feed for poultry; and in order that they may be utilized by the birds efficiently, they should be palatable, nutritious, economical and stable. They should contain the nutritive constituents in proper proportions to provide for the maintenance and production requirements. Some of the most common constituents of mash mixtures are discussed below.

Wheat Bran, Middlings and Shorts: These are the principal wheat by-products used in mashes. Wheat bran is the coarse outer covering of the wheat kernel. Wheat middlings consist mostly of fine particles of wheat bran and wheat germ; and should not contain more than 9.5 per cent crude fibre. Wheat shorts consist of fine particles of bran, wheat germ and offal obtained in the milling process; and should not contain more than 6.0 per cent crude fibre.

Oats and Barley: These cereals make a desirable feed used whole, coarsely ground or crushed. Tender oats grass has high food value. Barley is a useful ration if fed with caution. Birds reared on it are apt to develop fatty livers. It is a suitable constituent for fattening rations. Barley should not be fed to chicks under 3 or 4 weeks of age.

Gram: Gram (including horse gram) is good, but should be crushed before it is fed. All pulses are protein-rich but should not be considered as being the sole protein supplement.

Rice: Rice and rice by-products are the common feeds in the rice-growing regions, and can replace wheat or oats where these cereals are not grown. Rice bran can replace wheat bran to a great extent if not entirely. It is necessary, however, that the bran should be of good quality without any admixture of husk or other adulterants. It is a common practice to adulterate rice bran with powdered husk.

Corn Gluten Meal: Corn gluten meal is a by-product of the manufacture of starch. It contains a fair amount of protein (40-45 per cent) and can be used supplemented with animal protein, vitamins and minerals.

Jowar, Bajra, and Ragi: These millets are available particularly in South India where cereals like wheat or oats are expensive to be included in poultry feeds. They can be substituted for wheat or oats in feeding poultry along with the other locally available cereals such as rice and maize.

Potatoes: Potatoes cooked and mashed may be fed to poultry to a limited extent. It requires about 5 lb. of cooked potatoes to substitute 1 lb. of grain.

Groundnut Oil Cake: Groundnut oil cake is a useful vegetable protein food, particularly if supplemented by minerals. It is valuable for admixture with cereals and cereal by-products, and may be used up to 20 per cent of the ration.

Linseed Meal: Linseed meal is helpful in keeping the digestion of birds in good

condition. It is especially valuable during the moulting period, but should not constitute more than 5 per cent of the ration because of its laxative properties.

Cotton-seed Meal: Cotton-seed meal does not seem to be a very satisfactory ingredient of a poultry feed. Stoppage of normal secretions and constipation are said to result from its continued use. It should, therefore, be used sparingly, especially in the case of laying hens. Eggs produced on a diet containing over 6 per cent cotton-seed meal are liable to have spots on the yolk, and a pinkish tinge in the whites if the eggs are kept in storage.

Coconut Meal: Coconut meal can be used in poultry rations where it is cheap. It has, however, the defect of becoming rancid soon which makes it somewhat undesirable for incorporation in the feeds.

Soyabean Meal: Extracted soyabean meal is a valuable protein food and a very desirable ingredient of mashes used for egg-laying stock.

Meat Offal: Meat offal is a good source of animal protein. It is composed of animal intestines and stomachs from slaughter houses. When cooked, dried off by mixing with mashes, and fed to birds, it would serve as a rich source of protein. An adult bird should get at least one ounce of it per day along with oilcakes in a grain ration.

Meat Meal: Another potentially good source of animal protein, especially in this country where slaughter of cattle is banned, can be expected from the *Gosadans*, where all the old, useless and diseased cattle are maintained and death from natural causes is a common feature. The meat of dead cadavers, when cut into thin long strips, soaked in a saturated solution of salt for a few minutes, and then sun-dried, keeps well for a good length of time and would provide an excellent protein supplement in poultry mashes. It may be either cut into small pieces or powdered in a suitable mill.

White-ants: White-ants or termites (Fig. 99) are very rich in proteins and, therefore, an excellent source of this important nutrient, especially for the growing chicken (Fig. 100).

Silk Worm Pupae: Similarly the dead silk worm pupae left after the recovery of silk from the cocoons are a rich source of animal proteins. Large quantities of these are available in areas where silk production is a rapidly developing industry. At present these worms are either dumped in pits or converted into compost. In fact, the bad odour emitted by the putrefying pupae is a public health problem of growing dimensions in silk producing regions. The powdered pupae after they have been sun-dried and separated from the fibrous cocoons contain as much as 60 per cent protein, and would make a good protein supplement for the poultry mashes.

Blood Meal or Dried Blood: Blood meal or dried blood is no doubt rich in protein, but because of its unpalatability it is not a satisfactory protein supplement in poultry feeds.

Fish Meal: Fish meal is a protein-rich food, good for chickens over four to six weeks old. A good fish meal is rich in minerals as well as proteins (60 per cent) and may be fed up to 7 per cent in the ration without the risk of

imparting any taint to eggs or meat. Fish meal should be low in oil content (less than 6 per cent) and light in colour.

Distillery Sludges: The sludges left over after fermentation in the distilleries and the antibiotic factories are rich in vitamin B₁₂ which is the main constituent of the animal protein factor. After the recovery of the antibiotics in relatively pure condition, considerable amounts of vitamin B₁₂ and the particular antibiotic are left in the by-products, which when dried makes a good protein supplement.

Green Feeds: Green feeds are essential in the poultry rations mainly for three reasons: (1) to stimulate appetite, (2) to supply the bulk and help tone up the digestive tract and so assist in the process of digestion, and (3) to serve as additional source of essential nutrients. They may be given fresh or dried incorporated in the mash. Chickens seem to relish watery or succulent feeds. If the flock is on a green range, the birds themselves secure the greens in sufficient quantities. During winter, and when poultry are raised in confinement, the flock should be provided with dried green feeds or suitable substitutes in order that their health, condition and productivity do not suffer.

A wide variety of greens can be used, such as fresh and tender lawn grass, berseem, lucerne, sunhemp, leafy vegetable or vegetable wastes. Lucerne is best fed before flowering. Perennial tropical trees, e.g., *Leucaena glauca* and *Sesbania grandiflora* provide leaves rich in vitamins and can be fed to poultry as green feed. Green feeds should be cut fresh daily and fed chopped in hoppers or racks. These should not be cooked.

Liquids: Liquids are of importance for maintaining proper body temperature and functioning of other life processes. The following liquids are of importance.

WATER: About 55 to 60 per cent of a hen's weight is water and nearly 66 per cent of the contents of an egg is water. Water is, therefore, the principal and most important liquid which the chickens need. A flock of 100 laying hens will consume from 15 to 30 quarts of water a day, depending upon the intensity of production and the season of the year. It has little nutritional value, but is absolutely essential for the proper functioning of the vital processes of the bird. Water supplied to birds should be fresh, clean and pure.

MILK: Milk is an excellent source of animal protein. It also appears to act as a conditioner for improving the health of the birds. As a liquid it is fed in several forms.

- (i) Whole milk: It is not profitable to feed poultry with whole milk unless it is unusually cheap. There is also no advantage in feeding whole milk to poultry.
- (ii) Skimmed milk: Skimmed milk is rich in protein content and can be fed both sweet and sour; the sour milk is especially beneficial as an aid to digestion because of its lactic acid content. An adult bird consumes 4 to 6 ounces of milk and a chick 1 to 2 ounces daily.
- (iii) Buttermilk: It has a still higher feeding value than skimmed milk and is also relished by birds.

- (iv) **Whey:** It is not so valuable as the other forms of milk so far as nutrients are concerned, but is liked by poultry. It should be used when available.

FISH LIVER OIL: Fish oils are included in poultry mashes to provide the vitamin supplement. Shark liver oil is most commonly used, and is available from Government oil factories. The oil used for feeding poultry should have required potencies of the vitamins. It is safer to buy the oil directly from reliable factories, as it lends itself to easy adulteration at the hands of unscrupulous dealers. Shark liver oil is generally used in poultry rations during the summer months when greens are difficult to get. The admixture of shark liver oil for balancing the mash is of importance in feeding poultry, especially those kept indoors or in batteries all the time precluding them from getting enough of direct sunlight.

Minerals. Minerals are essential in the ration of producing hen, not only for maintaining the mineral stocks of her body (4 per cent) but also for the formation of egg shell, which is practically all mineral, constituting as much as 12 per cent of the whole egg. Minerals are also said to assist in the digestion of proteins and other nutrients. The principal sources of minerals are: Oyster shells, bonemeal, limestone, common salt and other salts.

Oyster Shell (river shells): Oyster shell is the principal source of calcium. The shells should be crushed to a convenient size and fed preferably separately in a hopper easily accessible to the birds at all times rather than as a part of the mash.

Bonemeal: Bonemeal is a good source of phosphate of lime. It may either be fed separately in a hopper, or, what would be better, as a part of the dry mash mixture at all times.

Limestone Grit: Limestone is an excellent source of shell forming material.

Common Salt: Common salt is essential as it increases the palatability of a ration and also aids digestion. It increases the consumption of water. If not already incorporated in a mineral mixture, it is usually fed as a part of the mash at the rate of not more than 1 per cent. If salted products like fish meal and meat meal are included in the mash, extra salt should not be given.

Manganese Salts: The two most commonly used salts are manganese sulphate and manganese chloride. One-fourth of a lb. of sulphate per ton of feed is adequate to meet the manganese requirements of chicks. If rice and rice products are fed, manganese salts are not required as they contain enough manganese in them.

Grit: Grit is necessary for the proper utilization of feeds supplied to poultry. It finds its way to the gizzard and aids it in crushing the feed. Good grit should be hard and sharp and be made available to the birds at all times in hoppers. Crushed rock and pebbles are satisfactory.

Computation of Rations. Proper formulation of poultry rations depends on an accurate knowledge of (1) the digestibility of the nutrients composing the various feeds, and (2) the nutrition requirements of the birds for maintenance and production purposes.

A good and satisfactory ration must possess the qualities already discussed. There is no single feed, no matter how nutritious, that has all the essential nutrients in the proper quantities and proportions. For this reason a number of available feeds of different types are mixed together, the quantity of individual components varying according to the purpose for which the ration is intended.

FEEDING METHODS

It is not only feeding a complete and well balanced ration that is necessary to ensure efficient growth and production, but it is also important to adopt proper methods of feeding in order to obtain the best results. The following methods are considered:

All-grain or All-scratch Method. Chickens having access to a good range of succulent grass or other green crops may grow fairly satisfactorily on a cereal-grain feed only, provided they can be supplied with plenty of liquid skimmed milk or buttermilk to drink. About 25 pounds of liquid skimmed milk or buttermilk per 100 hens daily would probably supply enough proteins lacking in the cereals, provided certain minerals and vitamins are added. Best results in egg-production are possible only when the diet includes mash made up of ground grains, necessary proteins of animal origin, minerals, and vitamins.

Grain-and-Mash Method. The most popular method of feeding growing chickens and the laying stock is what is called the grain-and-mash or the scratch-and-mash method. In this method the birds get a mixture of cereal grains as the scratch portion of the diet and a mash made up of ground grains, to which protein, mineral and vitamin supplements are added. The scratch grains are best fed in hoppers. The mash is always fed in hoppers which are so designed as to prevent any wastage. It is also important to use hoppers which prevent the chicks from getting into them and contaminating the feed with their dirty feet.

Growing chickens are usually fed only mash during the first few weeks. Then mixed grains are fed in increasing quantities as the growth advances. The laying stock is usually fed on a diet consisting of equal parts of mash and scratch (grains). The proportion of mash to grains recommended for different age groups is given in Table 18.

Table 18. APPROXIMATE PERCENTAGE OF MASH AND GRAINS FOR GROWING CHICKENS

Age of Chicks (Weeks)	6	8	10	12	14	16	18	20
Per cent of mash	95	90	80	70	60	50	40	30
Per cent of grains	5	10	20	30	40	50	60	70

All-mash Method. The all-mash system of feeding probably ranks second in importance. In reality this method is the same as the grain-and-mash method, except that the grains, instead of being fed intact and separately, are ground and mixed with the mash. The grains used in all-mash method should not, however, be finely ground.

The all-mash method of feeding is simple and labour saving although it does not admit of alterations in the feed according to the condition and appetite of the birds. All-mash feeding is ideal for laying hens or broilers in batteries.

Wet-mash Feeding. Wet-mash feeding is neither suitable nor is to be recommended on large poultry farms because of the greater skill and labour involved and the difficulty in maintaining strict hygienic conditions. It has nevertheless a place in the feeding programme of small units in the villages. In backyard poultry farming where considerable quantities of kitchen waste and table leavings are available it is generally convenient to feed the mash wet. Wetting the mash with water or preferably skimmed milk or buttermilk, increases the palatability of the mixture and encourages the birds to consume more, thereby stimulating growth and egg production.

Pellet Method. Pellets are made by compressing a dry-mash mixture under high pressure. These are cylindrical in shape and quite hard and differ in size depending upon the age of birds for which they are intended. From a poultry keeper's, especially backyard poultry keeper's and small farmer's points of view, it is a very convenient and easy method of providing poultry with balanced rations to ensure maximum growth and production. For a commercial poultry farmer the method is somewhat wasteful. The method should provide ideas for establishing factories to manufacture poultry feeds.

Free-choice Method. This method consists in placing before the birds large variety of individual feeds in separate containers, preferably, self-feeding hoppers. It affords the chickens a chance to eat as much of each single feed-stuff as they desire. It offers no particular advantage, while it entails the use of several feed hoppers and a considerable amount of time to keep them filled. It is also doubtful if the birds balance their rations to the extent it is necessary or desirable.

Home-mixture Method. Farmers can grow sufficient grain on their farms for their flocks instead of having to buy their poultry feed. Mashers could be made from ground grains according to formula, but proteins, minerals and vitamins have to be supplemented.

Protein could be provided by (1) buttermilk or skimmed milk available on the farm, (2) processed and preserved meat of carcasses of animals that die on the farm or meat meal obtained from the nearest *Gosadan*, (3) fish meal of good quality or meat offals from slaughter house, if they are cheap, and (4) to be supplemented with oil-cake which is both cheap and rich in protein.

An inexpensive but satisfactory mineral mixture can be made in accordance with the formula given earlier in this chapter. As regards green feed it may be grown by the farmer and supplemented during summer or severe winter, if necessary, by a good brand of shark liver oil which should be obtained from reliable suppliers.

FEED REQUIREMENTS

Feed costs represent more than one-half of the total cost of raising chickens. It should, therefore, be the concern of every poultry keeper to form some idea of

the quantity of feed required to produce the desired gain in body weight. An inadequate supply of feed, however well balanced, retards growth. It is, therefore, useful to know how fast chicks may be expected to grow in relation to the amount of feed consumed.

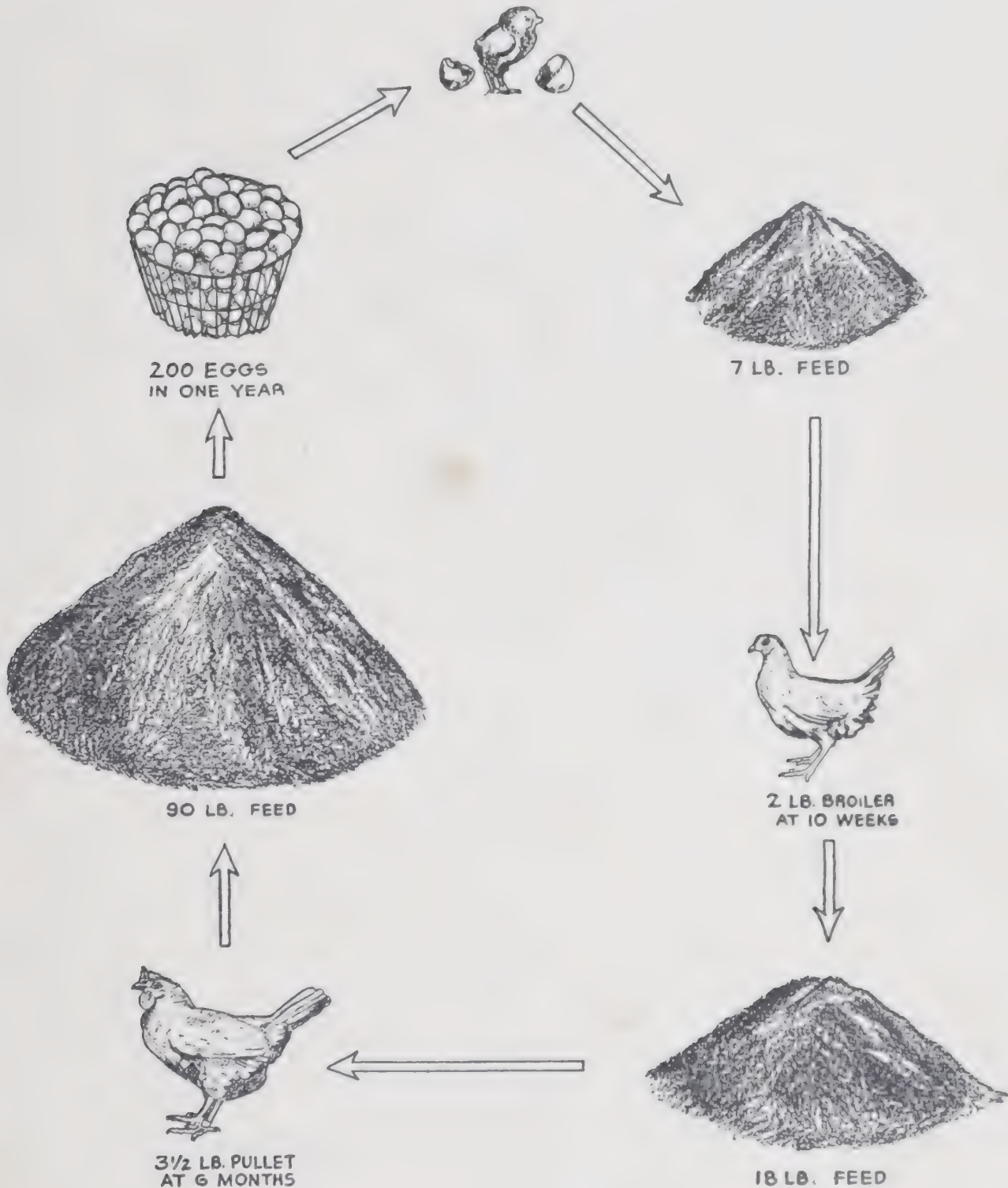


FIG. 103. QUANTITY OF FEED IN RELATION TO GAIN IN BODY WEIGHT AND EGG PRODUCTION
(From Bulletin No. 126 (1941) of the Agricultural Extension Service, Ohio State University)

It is a well established fact that males grow faster and consume more feed than females, and that chickens of the general-purpose breeds, such as Rhode

Island Reds and Plymouth Rocks, grow faster and, therefore, consume more feed than fowls of the egg-laying breeds such as Leghorns. Cross-bred chickens generally grow faster during the first 10-12 weeks than the pure-bred chicks. Chickens reared in confinement usually grow faster than those reared on range, other things being equal. It is also true that, in any given flock, the body weight per bird is approximately doubled every two weeks up to the end of six weeks, and thereafter the percentage gain in weight is lower, despite more feed being consumed. Table 19 gives the approximate average weight in pounds of a male (cockerel) and a female (pullet) of White Leghorns and general-purpose breeds, respectively, from hatching time up to the end of 24 weeks at intervals of two weeks.

The rate of growth is influenced considerably by at least four factors: (1) the inherent average size of the birds of a particular strain; (2) the amount of feed consumed from day-to-day, which is, to some extent, influenced by the kind of diet; (3) the protein content of the diet; and (4) methods of management, e.g., whether the birds are reared on range, or kept in confinement on the floor of the house, or brought up in a pen or in batteries.

Table 19. APPROXIMATE AVERAGE WEIGHT IN POUNDS PER MALE AND PULLET CHICK OF WHITE LEGHORN AND GENERAL-PURPOSE BREED AT WEEK INTERVALS

Age (weeks)	White Leghorns		General-purpose Breed	
	Males	Females	Males	Females
0	0.09	0.09	0.09	0.09
2	0.22	0.20	0.24	0.20
4	0.49	0.40	0.57	0.49
6	0.85	0.71	1.18	0.91
8	1.22	1.19	1.88	1.46
10	1.96	1.48	2.32	1.81
12	2.28	1.78	2.86	2.32
14	2.73	2.09	3.58	2.68
16	3.14	2.42	4.13	3.12
18	3.55	2.75	4.72	3.55
20	3.97	3.04	5.33	3.99
22	4.86	3.32	5.84	4.45
24	4.64	4.59	6.22	4.92

It is necessary that every poultry keeper should be able to estimate the amount of feed required to raise a certain number of chickens to marketable age

or until the pullets are about to lay. Figure 103 illustrates the feed requirements of fowls for a certain gain in body weight and for the production of eggs. Table 20 gives the number of pounds of feed required for different periods and the pounds of feed required per pound gain in weight as the chickens develop.

On the basis of these data it is easy to determine the approximate amount of feed required by a flock of chickens up to a certain age. To raise 100 chickens, consisting of almost equal number of each sex, the approximate quantity of feed required is indicated in Table 21.

When only pullets are raised, somewhat less feed is required than when approximately equal number of both sexes are raised together.

Feeding Pullets. Pullets are raised mainly for future egg production. They should, therefore, be fed and managed so as to enable them to grow well and remain healthy by the time they start laying. Pullet chicks which are fed with adequate quantities of well balanced rations during their growing period not only grow faster

Table 20. AVERAGE NUMBER OF POUNDS OF FEED REQUIRED PER POUND OF LIVE BODY WEIGHT AT DIFFERENT AGE IN RELATION TO THE AVERAGE NUMBER OF POUNDS OF BODY WEIGHT PER BIRD

Weeks	White Leghorns			General-purpose Breeds		
	Average weight per bird (lb.)	Average No. of lb. of feed consumed per bird	Average No. of lb. of feed per lb. of live-weight	Average weight per bird (lb.)	Average No. of lb. of feed consumed per bird	Average No. of lb. of feed per lb. of live weight
4	0.44	1.24	2.84	0.53	1.26	2.38
8	1.20	3.80	3.17	1.67	4.79	2.87
12	2.03	7.56	3.72	2.64	8.79	3.33
16	2.78	12.37	4.45	3.62	13.62	3.76
20	2.50	17.82	5.09	4.66	20.36	4.37
24	4.12	23.56	5.72	5.57	28.48	5.11

but also start laying earlier and lay more eggs than those which are not properly fed in the early period of their growth (Fig. 104). Pullets usually grow more uniformly in the absence of cockerels especially after about eight weeks of age. It is advisable, therefore, to separate the sexes early in life or as soon as the sexes can be distinguished, and to move the pullets to a good range when they are from six to ten weeks of age. The cockerels may be fed on a high protein diet if meant to be sold as broilers or fryers at 10 to 13 weeks, or they may be fed a lower protein diet to be sold as roasters at five to six months. A 15 to 16 per cent protein diet is satisfactory for pullets especially after they are eight weeks old.

A suitable diet for developing the pullets is a mash-and-grain mixture meant for growers. A mash containing about 18 to 20 per cent protein fed with equal parts of grains will amount to about a 15 or 16 per cent protein diet. If liquid

Table 21. APPROXIMATE AMOUNT OF FEED IN POUNDS REQUIRED TO RAISE HUNDRED CHICKS (BOTH SEXES APPROXIMATELY IN EQUAL PROPORTIONS) TO DIFFERENT AGES

Period	White Leghorns	General purpose breeds
To 4 weeks	110- 140	115- 145
To 8 weeks	350- 410	450- 510
To 12 weeks	720- 780	830- 930
To 16 weeks	1180-1280	1290-1430
To 20 weeks	1650-1900	1900-2150
To 24 weeks	2200-2500	2700-3000

skimmed milk is available in sufficient quantity, the animal protein supplements in growing mash could be omitted.

Feeding the Laying Stock. From the time the pullets are placed in the laying house, they require more feed daily until they are about ten months old, because pullets continue to grow till then. Table 22 gives the approximate quantities of feed required daily by 100 birds according to the body weight of the birds and per cent daily production, of the number of eggs laid daily by 100 birds.

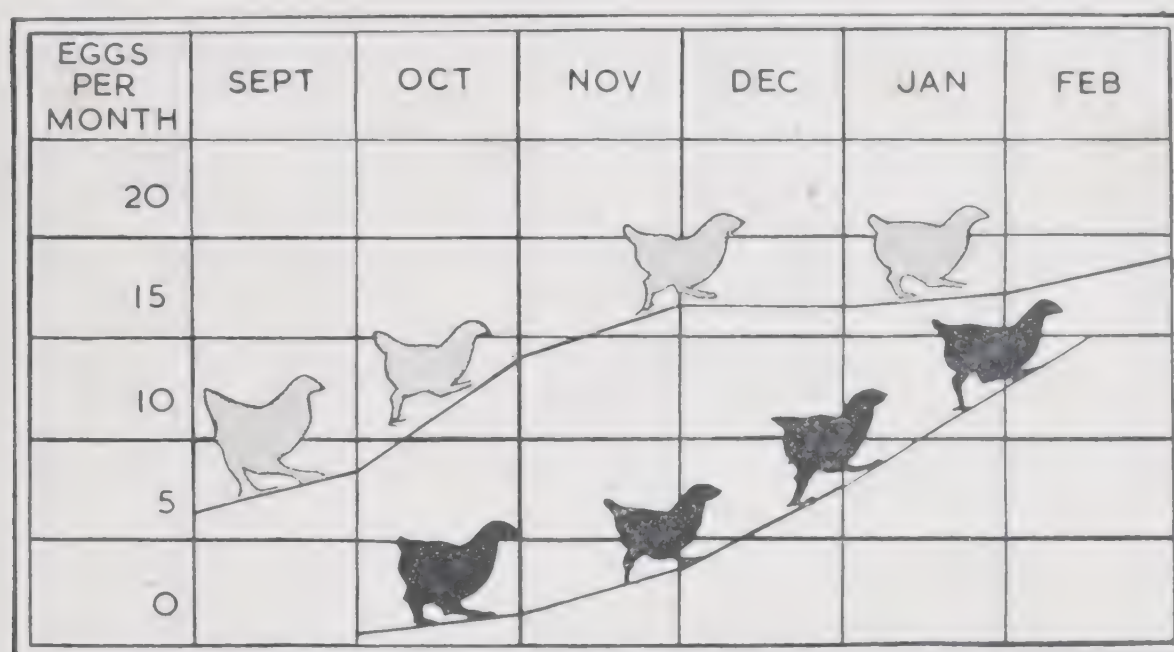
Table 22. APPROXIMATE NUMBER OF POUNDS OF FEED REQUIRED DAILY PER HUNDRED BIRDS ACCORDING TO SIZE OF BIRDS AND NUMBER OF EGGS LAID PER DAY PER HUNDRED BIRDS

(*T. C. Bayerly, University of Mary Land, 1941*)

Per cent Production	Body Weight (in pounds)				
	3	4	5	6	7
Feed required for 100 birds per day (lb.)					
0	12.8	15.5	17.9	20.2	22.3
10	14.2	16.9	19.3	21.6	23.7
20	15.6	18.3	20.7	23.0	25.1
30	17.1	19.8	22.2	24.5	26.6
40	18.5	21.2	23.6	25.9	28.0
50	19.9	22.6	25.0	27.3	29.4
60	21.3	24.0	26.4	28.7	30.8
70	22.7	25.4	27.8	30.1	32.2
80	24.2	26.9	29.3	31.6	33.7
90	25.6	28.3	30.0	33.0	35.1
100	27.0	29.7	32.1	34.4	36.5

FEEDING PRACTICES

Chicks are generally given their first feed as soon as they are placed in the brooder. This will be about 36 hours after they hatch out, during which time, depending on whether they are hatched by natural or artificial methods, they are either left under the broody hen or in the hatching trays of the incubator without being fed. Feed and water should be ready for the chicks when they are placed in the brooder to prevent their eating litter, droppings, or any other material that is handy. It is necessary to repeat that the kind of feed a chick receives during the first few weeks of its life has an important bearing on its growth and development. The ration must, therefore, be carefully computed and must contain all the vitamins and 20 per cent protein. It is not possible to provide for this with



This bird represents those pullets which were well fed during the growing period.



This bird represents those pullets which were not well fed during growing period.

FIG. 104. COMPARISON OF THE PERFORMANCE OF WELL-FED PULLETS WITH ILL-FED PULLETS DURING THE GROWING PERIOD

cereals alone. Chicks are, therefore, best started on all-mash feed, which is continued until they are two to three weeks old (Fig. 101), when a suitable grain mixture may be included. Only a small quantity of broken grain should be fed to start with, and equal quantities of grain and mash should be fed by the time the chicks are 12 to 16 weeks of age. The formulation of a chick mash should, as far as practicable, depend on the locally available ingredients, care being taken to see that the protein content is from 18 to 20 per cent. The computation of a few chick mashes that are being used successfully in some of the poultry farms in India are given below:

POULTRY KEEPING IN INDIA

GRAIN:

Maize (crushed)	..	..	..	1 part by weight
Bajra	..	..	..	1 ,, ,, ,,
			or	
Maize (crushed)	..	..	..	1 ,, ,, ,,
Rice or Jowar (broken)		..	..	1 ,, ,, ,,
			or	
Rice or jowar (broken)	..	..	..	1 ,, ,, ,,
Ragi	..	..	..	1 ,, ,, ,,

MASH:

Wheat bran	..	..	..	35 parts by weight
Maize meal	..	..	..	35 ,, ,, ,,
Ground oats	..	..	..	10 ,, ,, ,,
Groundnut cake meal	..	..	..	19 ,, ,, ,,
Fish meal or meat offal (if skimmed milk is not available)	..	..	..	25 ,, ,, ,,
Salt	..	..	..	1 part ,, ,, ,,
			or	
Wheat bran	..	..	..	20 parts by weight
Maize flour	..	..	..	30 ,, ,, ,,
Barley flour	..	..	..	20 ,, ,, ,,
Groundnut cake meal	..	..	..	20 ,, ,, ,,
Fish meal	..	..	..	10 ,, ,, ,,
Limestone or oyster shell		..	..	1 part ,, ,, ,,
Common salt	..	..	..	0.5 ,, ,, ,,

Skimmed milk or buttermilk should be made available all the time. If this is not available, fish meal should be increased to 25 parts for every 100 parts of mash, or in its place meat offals, 25 parts for every 100 parts, should be included. A good feed may be prepared according to the following formula:

Wheat bran	..	..	..	40 parts by weight
Ragi flour	..	..	..	30 ,, ,, ,,
Groundnut cake meal	..	..	..	18 ,, ,, ,,
Fish meal	..	..	..	20 ,, ,, ,,
Bonemeal	..	..	..	1 part ,, ,, ,,
Common salt	..	..	..	1 ,, ,, ,,

The quantity of fish meal should be reduced in proportion to the availability of skimmed milk, and may be altogether done away with if plentiful supplies of skimmed milk are available at all times. If meat offals or white ants or silk worm pupae are available, the same may replace fish meal.

Chicks should have access to direct sunlight, failing which veterinary grade shark liver oil should be added to the mash in the proportion of 1 per cent. Fresh succulent green feed such as sunnhemp, lucerne, tender grass, cabbage leaves, berseem, etc., should be finely chopped and freely fed to the chicks, either by itself or mixed with mash, from the second week onwards.

The first feed to the chicks should be given on a sheet of old newspaper or a flat board at the rate of about one desert spoonful for every twelve chicks. The chicks can be encouraged to start eating the first meal by gently tapping the paper or the board with the finger tips. Baby chicks should have feed easily accessible to them with plenty of feeding space, so that they may learn to eat readily. Small trough feeders, about one inch deep and two or three inches wide, made of wood or metal may be used during the first few days. After two or three days, when the chicks have learned to eat, large trough feeders with wire guards or a reel to prevent the chicks from getting into feed should be used. Such protected feeders help to check unnecessary wastage of feed, and prevent the spread of disease by keeping the droppings out of the feed.

One inch of feeder space should be allowed for each chick up to two weeks of age, when the space should be increased to two inches.

The first two or three feeds may be given inside the hover or foster-mother, and afterwards the feeders should be distributed around the hover so that all chicks have a chance to eat. If a brooder box is used the feeds and skimmed milk (or water) should be placed in the feeders on the boards specially provided for the purpose outside the box from the first week onwards. In order to prevent young chicks from straying too far away from the brooder, wooden or corrugated card-board guards about 10 to 12 inches high should be provided all round the brooder. The guard should be moved farther away gradually as the chicks grow up so as to provide more running space for them. At the end of the second week the guards should be removed completely. Water or skimmed milk should always be available for the chicks and offered in special fountains.

As soon as the chicks have learnt to eat out of the feeders, both the feeders and fountains are best placed on wire covered platforms.

After eight or ten weeks of age the smaller feeders should be discarded for larger ones. If the birds are shifted to the range or rearing houses surrounded by pens, the feeding should be done in properly protected feeders. At least one linear foot of hopper-space should be allowed for every ten birds after they are eight weeks old. One feeder in each brooder house is useful on rainy days and when the birds have to be shut in. The equipment needed to raise chicks to maturity is illustrated in Fig. 105.

During the first few weeks, it is advisable to feed the mash in such quantities that it will be possible to give fresh mash four times daily. Later, it can be kept

before the birds all the time. Occasionally, it may be necessary to restrict the grain content in order to promote proper mash consumption. Wide variation in grain consumption is permissible after the chicks are three months old. A less expensive growing mash may replace the starting mash after the birds are 10 to 12 weeks old.

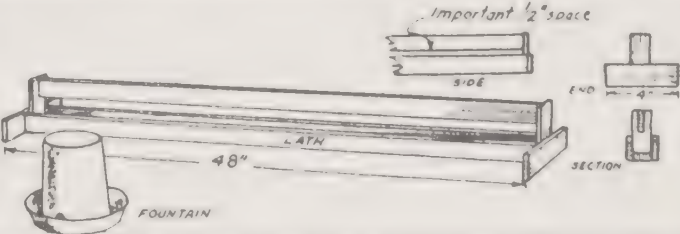
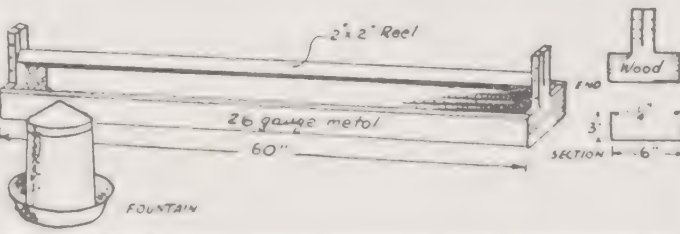
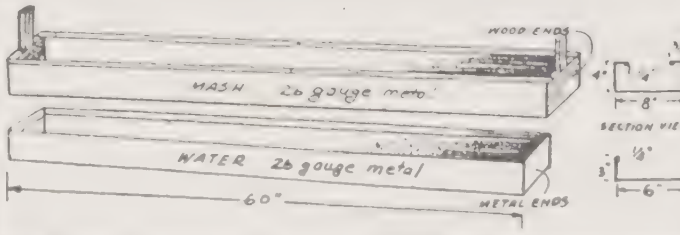
EQUIPMENT	AGE OF CHICKS	EQUIPMENT PER 100 CHICKS
	 ONE DAY	2 FEED TROUGHS 2 FOUNTAINS
	 TEN DAYS	2 FEED TROUGHS 2 FOUNTAINS
	 SIX WEEKS	2 FEED TROUGHS 2 WATER TROUGHS

FIG. 105. EQUIPMENT NEEDED TO RAISE CHICKS TO MATURITY (From Circular 285 (1936), Extension Service of the College of Agriculture, University of Wisconsin, Madison)

Fine, insoluble, grit should be given from the start by spreading a small amount on the mash, at the time of the first feeding. Later it is kept in separate containers. Oyster shell (river shells) or fine limestone grit should be provided after the pullets are about four months old.

Feeding Layers. Experience has shown that laying hens when fed with properly balanced laying ration produce many more eggs than when they are allowed to scavenge or are fed with improperly balanced feeds. The main object of feeding laying hens is to get the maximum egg production at the minimum cost. In order to get the best results, the grain mixture and mash should be fed in equal quantities. The mash, limestone or river shells, and water should be made available to the birds at all times.

While computing the requirement of grain mixture and the mash, due consideration should be given to the locally available food-stuffs in order to keep the cost low.

The following formulae would be found useful in planning the feed.

FEEDING PRINCIPLES AND PRACTICES

GRAIN MIXTURE: A mixture of equal parts of two or more grains like yellow maize, bajra, oats, barley, jowar, rice, ragi, wheat, etc., depending on the local availability. The grain mixture should be provided at the rate of about 2 ounces per day per bird in separate hoppers.

MASH:

Wheat bran	..	..	..	30 parts by weight
Yellow maize meal	..	..	..	48 ,, ,, ,,
Ground oats	..	..	..	10 ,, ,, ,,
Groundnut cake meal	..	..	..	11.5 ,, ,, ,,
Common salt	..	..	..	0.5 part ,, ,, ,,
Total	..	..	..	100 parts by weight

To this, addition is made of fish meal in the proportion of 7 to 10 parts for every 100 parts, or separated milk or buttermilk at the rate of 4 ounces per bird per day or meat offals at one ounce per bird per day. Meat offals should be cooked and minced before feeding, which is done best by mixing the stuff with a part of the mash which the birds should consume immediately. In addition to this, chopped fresh succulent greens should be fed and crushed unburnt limestone containing not less than 35 per cent of calcium carbonate should always be accessible to the birds.

The grains are fed at the rate of 2 ounces per bird per day in two feeds, both morning and evening, as the first and the last feed for the day, the mash being kept in the hoppers at all times.

Another mash mixture is given below, the grain mixture being the same as above:

Wheat bran	..	..	..	15.0 parts by weight
Rice bran	..	..	..	10.0 ,, ,, ,,
Maize flour	..	..	..	30.0 ,, ,, ,,
Barley flour	..	..	..	20.0 ,, ,, ,,
Groundnut cake meal	..	..	..	18.0 ,, ,, ,,
Fish meal	..	..	..	5.0 ,, ,, ,,
Limestone	..	..	..	1.5 ,, ,, ,,
Common salt	..	..	..	0.5 part ,, ,, ,,
Total	..	..	..	100.0 parts by weight

The grain mixture and the mash are fed at the rate of 2 ounces each per bird per day. Besides, any green stuff available according to the season should be fed at the rate of one to two ounces per bird per day. The limestone or river shells should be broken into small bits and if fed separately should be omitted from the mash. Mash mixture can be changed according to the availability and cheapness of various

ingredients. *Bajra*, *jowar*, *ragi*, *cheena*, wheat and rice can partially replace both maize and barley meals. Similarly, the ratio of wheat and rice bran can be reversed if the quality of rice bran is good. Groundnut oilcake can also be replaced partially or wholly by linseed, *sarson*, cotton seed and coconut cakes. Fish meal may be replaced by skimmed milk, buttermilk, meat offals, meat meal, silkworm pupae meal, etc.

A feeding schedule which has been found useful on a State Government farm in the South is given below:

GRAIN:

Ragi	..	..	..	1 part by weight
Jowar (Sorghum)	..	..	..	1 „ „ „
Paddy	..	..	..	1 „ „ „

About 2 ounces of the above mixture per bird per day in one feed in hoppers is given as the last one for the day.

MASH:

Ragi flour	..	..	..	35 parts by weight
Wheat bran	..	..	..	20 „ „ „
Rice bran	..	..	..	20 „ „ „
Groundnut cake meal	..	..	..	15 „ „ „
Fish meal	..	..	..	10 „ „ „
Total	..	..	..	100 parts by weight

In addition to the above, bonemeal and salt are fed at the rate of one pound and half a pound respectively for every 100 lb. of the mash: finely chopped greens—lucerne or any vegetable tops are fed separately at the rate of 2 ounces per bird and water and shell grit are provided in separate containers at all times.

Mash compositions for layers adopted in some of the countries where rice is the major crop are given below:

Philippines

GRAIN-AND-MASH RATION FOR LAYERS:

Grain—Either rice or corn or both	..	..	..	40 parts by weight
Mash—Rice bran	..	..	..	30 „ „ „
Copra meal	..	..	..	10 „ „ „
Ground corn	..	..	..	20 „ „ „
Fish meal or shrimp meal	..	..	..	100 parts by weight
Total	..	..	..	

FEEDING PRINCIPLES AND PRACTICES

The ration is fed as one part of grain and one part mash.

ALL-MASH FOR LAYERS:

Ground corn	..	..	..	50 parts by weight
Rice bran ..	..	..	..	20 „ „ „
Copra meal	..	..	..	10 „ „ „
Fish meal or shrimp meal	..	..	..	20 „ „ „
Total	..	..	..	100 parts by weight

SUPPLEMENTS:

Ground shells	..	..	..	2 per cent
Cod liver oil	..	..	..	2 „ „
Green feed	..	..	..	Handful every two days

The mixture minus cod liver oil proves to be highly profitable for layers kept in pens. Some of the birds fed on this ration are said to have laid more than 300 eggs a year. Another all-mash ration recommended by the Bureau of Animal Industry of the Philippines is as follows:

Ground corn	..	..	..	37.0 parts by weight
Rice bran ..	..	..	..	30.0 „ „ „
Copra meal	..	..	..	10.0 „ „ „
Fish meal ..	..	..	..	10.0 „ „ „
Soyabean oil meal	..	..	..	5.0 „ „ „
Whey ..	..	..	..	3.0 „ „ „
Ipil-ipil (<i>Leucaena glauca</i>) leaf meal	..	..	..	2.0 „ „ „
Shell powder	..	..	..	2.0 „ „ „
Cod liver oil	..	..	..	0.5 „ „ „
Common salt	..	..	..	0.5 „ „ „
Total	..	..	..	100.0 parts by weight ✓

Japan

GRAIN-AND-MASH FOR LAYERS:

Maize	..	..	..	20 parts by weight
Wheat	..	..	..	18 „ „ „
Sweet potato silage (calculated as dried)	..	..	..	20 „ „ „
Wheat bran	..	..	..	14 „ „ „
Rice bran ..	..	..	..	11 „ „ „
Fish meal ..	..	..	..	12 „ „ „
Silkworm meal pupae (oil extracted)	..	..	..	5 „ „ „
Total	..	..	..	100.0 parts by weight

POULTRY KEEPING IN INDIA

Many hens fed with the above are said to have produced more than 300 eggs a year.

Malaya

CHICK MASH:

Yellow maize meal	..	..	..	40 parts by weight
Rice bran	..	..	..	24 „ „ „
Dried skimmed milk	..	..	..	20 „ „ „
Fish meal	..	..	..	10 „ „ „
Dried yeast	..	..	..	3 „ „ „
Red palm oil	..	..	..	2 „ „ „
Common salt	..	..	..	1 part „ „
Total	..	..	..	100 parts by weight*
*Digestible Protein				15.4
Starch Equivalent				71.9

GROWERS MASH:

Yellow maize meal	..	..	..	53 parts by weight
Rice bran	..	..	..	24 „ „ „
Fish meal	..	..	..	10 „ „ „
Groundnut cake (decorticated)	..	..	..	10 „ „ „
Bonemeal or limestone	..	..	..	3 „ „ „
Total	..	..	..	100 parts by weight*
*Digestible Protein				13.2
Starch Equivalent				72.0

LAYERS MASH:

Yellow maize meal	..	..	..	30 parts by weight
Rice bran	..	..	..	20 „ „ „
Copra cake (double pressed)	..	..	..	10 „ „ „
Groundnut cake (decorticated)	..	..	..	10 „ „ „
Fish meal	..	..	..	24 „ „ „
Red palm oil	..	..	..	3 „ „ „
Bonemeal or limestone	..	..	..	2 „ „ „
Common salt	..	..	..	1 part „ „
Total	..	..	..	100 parts by weight*
*Digestible Protein				18.6
Starch Equivalent				72.0

FEEDING PRINCIPLES AND PRACTICES

Thailand

ALL-MASH LAYING RATION:

Rice bran	60 kg.
Broken rice	8 „
Ground yellow maize	8 „
Ground soyabean cake	4 „
Ground peanut cake	4 „
Copra meal	5 „
Fish meal	8 „
Ground oyster shell	2 „
Ground dried legume leaf	3.5 „
Common salt	1 „
Shark liver oil plus Vit. D	1 „
Total	104.5 kg.

Hens (White Leghorn) fed on the above have laid as much as 336 eggs in a year in a laying contest.

Singapore

GRAIN-AND-MASH-MIXTURE FOR POULTRY

Under Two Months			Over Two Months		
Oats	25 parts by wt.		Coconut cake	10 parts by wt.	
Coconut cake	10 „ „ „		Groundnut cake	5 „ „ „	
Groundnut cake	10 „ „ „		Rice	30 „ „ „	
Rice bran	20 „ „ „		Maize	20 „ „ „	
Maize	20 „ „ „		Broken rice	5 „ „ „	
Fish meal	10 „ „ „		Oats	10 „ „ „	
Milk	3 „ „ „		Skimmed milk	5 „ „ „	
Cod liver oil	2 „ „ „		Cod liver oil	3 „ „ „	
			Fish meal	10 „ „ „	
			Minerals	2 „ „ „	
Ration:			Ration:		
1 to 2 ounces per bird daily			2 to 4 ounces per bird daily		

POULTRY KEEPING IN INDIA

GRAIN-AND-MASH-MIXTURE FOR POULTRY

(Concluded)

Under Two Months				Over Two Months			
Or alternatively							
Rice	..	..	.. 30 parts by wt.	Rice bran	..	..	.. 30 parts by wt.
Rice bran	..	..	.. 50 ,, ,, ,,	Maize	..	..	.. 20 ,, ,, ,,
Groundnut cake	..	..	.. 5 ,, ,, ,,	Oats	..	..	.. 10 ,, ,, ,,
Fish meal	..	..	.. 10 ,, ,, ,,	Coconut cake	..	..	.. 10 ,, ,, ,,
Cod liver oil	..	..	.. 3 ,, ,, ,,	Fish meal	..	..	.. 10 ,, ,, ,,
Mineral mixture	..	..	.. 2 ,, ,, ,,	Vegetables	..	..	.. 18 ,, ,, ,,
Ration: One oz. per day			..	Ration: 2 oz. per day			
STARTERS				LAYERS			
Maize	..	..	.. 40 parts by wt.	Maize	..	..	.. 45 parts by wt.
Rice bran	..	..	.. 25 ,, ,, ,,	Rice bran	..	..	.. 32 ,, ,, ,,
Wheat	..	..	.. 15 ,, ,, ,,	Wheat	..	..	.. 15 ,, ,, ,,
Soyabean	..	..	.. 15 ,, ,, ,,	Soyabean	..	..	.. 5 ,, ,, ,,
Fish meal	..	..	.. 5 ,, ,, ,,	Fish	..	..	.. 2 ,, ,, ,,
Ground limestone	..	..	.. 1 lb.	Ground limestone	..	..	.. 2 lb.
Salt and magnesium	..	..	.. ½ lb.	Salt and magnesium	..	..	.. ½ lb.
Aurofa	..	..	.. ½ lb.	Min-a-vit	..	..	.. ½ lb.

Feeding Hints for Rural Areas. The bulk of poultry in the villages consists, at present, of the mongrel *desi* birds. They are maintained in small units on free range and have to feed for themselves by foraging and scavenging on the manure dumps and the village fields, where they pick up a few fallen grains, grass seeds insects, worms, green grass and leaves. It is just incidental that the farmer's wife, may throw now and then a handful of grains. Under such conditions the birds are not only under-fed, but the feed that they get is also unbalanced. It is no wonder, therefore, that they show too vividly all the manifestations of under-feeding and malnutrition, such as slow rate of growth, late maturity and low egg production. The average annual egg production of a *desi* hen is about 50. ✓

It has been shown that by proper feeding alone the laying capacity of the *desi* hens can be doubled, and if proper selection and breeding are combined with balanced feeding not only the production of eggs increases but the size of eggs also improves steadily. The need for proper feeding practices is, therefore, apparent. The need will increase further when improved poultry are introduced

in the village economy and the *desi* birds are upgraded.

Some suggestions for improving the feeding practices in the villages are given below:

(1) Provision for feeding at least half to one ounce ($\frac{1}{4}$ to $\frac{1}{2}$ chhatak) of a mixture of any locally available grains (cereals and millets) per head of the flock daily should be made. To this should be added quantities of bran, grain and grain screenings, kitchen waste, etc., that may be available in the farmer's house to make up the mixture to at least two ounces (including the grains).

(2) As much of the surplus buttermilk as may be available in the house should be fed to the birds.

(3) Any available greens in the house or the fields such as vegetable tops, leaves and waste, tender grass, etc., should be utilised for feeding the birds. Perennial quick growing tropical trees, such as *Sesbania grandiflora* and *Murungo minutiflora* which can be used also for human consumption should be grown in the backyard of the houses and their leaves used in poultry rations.

(4) Meat scraps, meat offals, white ants, dried and powdered silkworm pupae, wherever available, should be utilised for the purpose.

(5) Nocturnal insects which generally abound in the villages and which are especially prolific after the rains can be trapped and used for feeding poultry. An ingenious method* of trapping these insects consists in placing a hurricane lantern or even an oil lamp inside the village poultry house at night time. The insects are attracted to the light and are eaten by the birds immediately or as soon as the day dawns when some of them are found lying dead all round the lamp. It is necessary to provide $\frac{1}{2}$ inch chicken wire-mesh guard round the light to prevent the birds from getting burnt. Where the poultry houses are made out of inflammable materials such as straw, hay, dried twigs, etc., the use of a naked lamp inside the house should be avoided. It may be placed outside the house, so that any of the insects which are attracted to the light may be available to the birds in the morning when the poultry are let out.

* This method is suggested by Dr. M. S. Randhawa, as having worked satisfactorily.

II

DISEASES AND THEIR CONTROL

THE high rate of mortality among the fowls, and the resulting heavy losses to the poultry keeper are by far the biggest problem besetting poultry development in India. It is estimated that more than 50 per cent of the birds are lost annually due to diseases and other causes. This big loss sets at naught the very idea of economic production. Besides, the frustration which the poultry keepers suffer is a serious deterrent to the expansion of the industry.

With the intensification of poultry production in the country, as envisaged under the poultry development schemes, the problem of disease control would assume increasing importance. Under the improved methods of breeding, feeding and management the hens lay eggs over a large part of the year instead of occasionally. This puts them to heavy strain and saps their reserves of vitality. As a consequence, the danger of loss from diseases, parasites and other causes increases progressively. Hence the need for special safety measures.

The several causes of poultry losses, and the safeguards needed against them may be considered under the following broad heads:

1. *Accidents*: Losses from accidents, mostly from attacks by predatory animals and birds, total to about 50 per cent of the poultry losses.
2. *Infectious Diseases*: The diseases caused by viruses, spirochaetes and bacteria account for about 40 per cent of the total losses.
3. *Parasites*: Protozoan parasites and various internal and external parasites are the third important cause of mortality.
4. *Non-infectious Diseases*: Most of these result from, (a) faulty nutrition, (b) miscellaneous environmental influences, and (c) genetical factors.

PREDATORS

A wide variety of predators are known to attack poultry. These may be prey birds, such as the crow, eagle, kite, hawk, owl, etc., or animals like the cat, fox, jackal, rat, bandicoot and mongoose. The cobra and other venomous snakes can also be classed among the predators, although the destruction caused by them is mostly accidental. A snake may enter the poultry premises accidentally or in an attempt to escape from an enemy, and on being confronted by inquisitive or frightened birds may attack them in self-defence or out of vexation. There have

been instances when a single cobra having gained access to a colony house, killed more than half the birds before making its escape.

Broody hens, in addition to providing the necessary warmth to the young chicks also guard them against attack from the predatory birds. But when chicks are raised by artificial incubation, special arrangements for their protection have to be made.

For protection against nocturnal enemies like cats, foxes, and jackals, particular attention has to be given to the housing of the birds at night. The usefulness of wire netting for this purpose needs no emphasis. Besides, the offenders should be shot down, for that would not only eliminate the immediate threat but would also scare away the other prowlers for some time.

Rats and bandicoots cause considerable damage to poultry. They also eat away the poultry feeds if not properly stored in rat-proof containers. Rats attack roosting hens and inflict severe bites on the abdomen which produce cannibalism in the birds. Keeping the poultry houses free from surplus feed, regular use of rat traps, providing lights in the premises, and use of rat poisons which are not harmful to chicks, are measures that can be suggested to tackle the menace.

Cobras and snakes should be killed whenever sighted. The premises and the surroundings should be carefully examined for any burrows, holes and nests which may harbour them, and such hiding places should be closed or destroyed at once.

INFECTIOUS DISEASES

Poultry birds are subject to a large number of diseases, some of which spread rapidly through the flock and cause high mortality. These diseases are generally transmissible, and are caused by bacteria, viruses and fungi (moulds). It is necessary to take effective measures against the disease-producing agencies.

Preservation of the health of a flock should be of greater concern to every poultry keeper than saving a few stricken birds. The reasons are obvious, namely:

- (1) Individuals in the flock, unless they are of exceptional breeding value, are of little significance to merit the attention and the expenses needed for treatment.
- (2) Treatment is seldom of much avail.
- (3) Birds that may recover, though apparently healthy, may still harbour the infection and serve as carriers capable of communicating the disease to the healthy stock.

The problem of disease control in poultry is, therefore, one that relates more to the protection of the flock than to the saving of individuals. It calls for close attention to the principles of hygiene and sanitation.

Poultry hygiene has a two-fold objective in that it aims, on the one hand, at maintaining the birds in good health, and, on the other, at guarding them against disease. As regards the former, conditions have to be created under which the vital functions of the body can be performed with maximum efficiency. The latter concerns itself with the disease control measures.

Among the factors promoting health and body efficiency, the most important are: (1) soundness of body and constitution; (2) adequate nutrition, (3) environmental sanitation, proper housing, and sound management; and (4) control and eradication of transmissible diseases. The first three have already been dealt with in the preceding chapters. We shall, therefore, focus attention here on the question of disease control.

The transmissible diseases, also referred to as infectious or contagious diseases, often affect the entire flocks and are, therefore, of vital concern to the poultry keeper. It would be useful to explain how these spread from bird to bird and from place to place.

It is not always easy to determine exactly how a particular disease finds its way into a flock, but it is certain that every outbreak originates from some infected bird which serves as the prime propagator. It is known that infectious diseases like the Ranikhet and the tick fever are generally introduced into healthy flocks through newly purchased birds or through those returning from poultry shows and exhibitions. The offal of the birds killed for table, often becomes the starter of an infection. Wild birds, insects (ticks, mites, fleas, flies and mosquitoes), animals (dogs, cats, etc.), as well as human beings (workers, visitors, poultry hawkers and buyers) also contribute to the spread of infection from one place to another.

Transmission of infection from bird to bird in a flock takes place through the food and water contaminated with the saliva and droppings of the sick birds, through biting insects, and in some cases also through inhalation. The soil upon which the flock is kept is invariably one of the most active factors in the spread of the disease as well as in the prolongation of the hazards associated with it.

The following measures are suggested for the control and prevention of transmissible diseases:

(1) All newly purchased birds, or those brought back from shows and exhibitions, should be quarantined and kept isolated for at least two weeks. They should be looked after by separate attendants.

(2) The offals of the chickens got from the market and killed for table, i.e., crops, bills, intestines, claws, etc., must not be thrown about the yard within the reach of the flock. They should be buried as deep as possible or burnt.

(3) The young stock should not be mixed up with the older stock. Nor should the former be raised on a ground where the latter was previously housed without first suitably treating the site. The old birds usually harbour disease without themselves showing any apparent signs of it, and transmit the infection to the young stock.

(4) The young birds should be raised on clean land on a system of periodical rotation. If the same land has to be used continuously, it must be ploughed frequently (two or three times a year) and planted with new fodder crops or grasses.

(5) Visitors should not be allowed to enter poultry pens and houses.

(6) The poultry houses and the feeding and watering utensils should be cleaned at least once a day, and the pens and yards once a week. They must be disinfected occasionally.

(7) Dampness and overcrowding should be avoided by improving drainage and providing ample living space. The poultry houses should receive plenty of direct sunlight, which is not only a good disinfectant but also an effective safeguard against dampness.

(8) The stock should be fed adequately and with well-balanced rations to build up their resistance against disease.

(9) Anything rotten or spoilt should not be thrown where the chickens can get at it.

(10) Tick-proof perches should be provided in the poultry houses to prevent attack by ticks.

(11) All the young birds should be vaccinated against Ranikhet disease as soon as they are six weeks old, and against fowl pox as soon as it can be done safely.

If an infectious disease breaks out in a flock, the following additional precautions should be taken:

(1) The apparently healthy birds should be segregated from those showing signs of the disease, and provided with separate attendants and food and water containers.

(2) The blood and body fluids of a sick bird should not soil the floor of the poultry house or the soil of the yards.

(3) All sick birds should be killed and burnt or buried.

(4) After handling a sick or dead bird the hands should be disinfected with a good disinfectant such as Creolin or Dettol solution.

(5) Houses, pens, feeding troughs, drinking utensils, and all other equipment should be washed with hot water and disinfected with a 5 per cent solution of phenyl or 2 per cent solution of Lysol.

(6) Potassium permanganate should be added to drinking water, just enough to give it pink colour.

The control measures suggested above are easy to adopt on large and organised farms, but may not be practicable under village conditions. Birds in the villages are generally kept on free range, and chickens and adult birds from different units intermix freely on the manure dumps and share water from a common source. The following suggestions are helpful in their case:

(1) Poultry keepers in the villages should co-operate with one another and act collectively in taking the necessary preventive and disease control measures.

(2) All the young stock over six weeks old should be vaccinated against Ranikhet disease, and all those aged over eight weeks against fowl pox—at any rate before the chicks are three to four months old.

(3) The housing conditions should be improved and the birds fed with balanced feeds, as recommended in the chapters on Housing and Feeding, respectively.

(4) In the event of an outbreak of disease intimation should be given promptly to the nearest veterinary hospital and necessary aid sought.

DISEASES CAUSED BY VIRUSES AND BACTERIA

Most of the poultry diseases common in India are those which are caused by filterable viruses. Some of these viruses are highly virulent, and the diseases induced by them generally result in heavy mortality. Diseases caused by bacteria are relatively less common. In the order of importance, Ranikhet (Newcastle disease), Fowl pox, Tick fever (Spirochaetosis), Infectious coryza, and Avian leucosis (fowl paralysis) are generally encountered. Fowl cholera and Tuberculosis also occur though very rarely.

It is outside the scope of this chapter to deal with the poultry diseases exhaustively. Only a broad account of these is given here. The readers should consult other literature for more detailed information.

Ranikhet Disease. The Ranikhet disease, also known as Newcastle disease, is a very dreadful infection, and by far the most destructive of the poultry diseases. It is caused by a filterable virus which can easily be isolated in the laboratory from the tissues of the infected birds.

Symptoms: The disease may affect birds of all ages. In chicks of a few days to a few weeks of age, respiratory symptoms such as sneezing, coughing and gasping for breath are noticed. But in severe outbreaks many young chicks may die suddenly without any apparent signs of illness. Those that may survive for a few days generally suffer from a greenish watery diarrhoea which has a characteristic odour. If death does not occur at the diarrhoea stage, nervous symptoms such as twisting of the head over the back or under the body or from side to side may develop. The chicks stagger or walk in circles, and rapidly develop paralysis of one or both legs and/or of one or both wings. Appetite is usually lost and the birds become dull and huddle together in corners. Mortality may range from 80 to 90 per cent over a short period.

In older birds a sudden outbreak of coughing, sneezing and gasping may be noticed. This is soon followed by a yellowish green watery foetid diarrhoea, marked respiratory distress, nervous symptoms and paralysis (Fig. 107), ending ultimately in death in 80 to 90 per cent cases.

Treatment: Treatment is not of any use. A reliable prophylactic vaccine is now being prepared in most of the State Veterinary Biological Products Institutions. Healthy birds vaccinated with it acquire life-long immunity, which starts within three to four days of the vaccination. It is of advantage in controlling an outbreak in its very early stages when most of the birds may not have been infected. By segregating the apparently healthy stock from the sick birds, and by immunising them with the vaccine, the disease can be prevented from spreading. Some casualties (the number depending on the duration and intensity of the infection) cannot, however, be avoided since the disease may be in the incubation stage even when the birds may appear unaffected.

The most effective method of preventing and eradicating the disease consists in organising mass vaccination campaigns and vaccinating all the birds over six weeks old (Fig. 106). For complete safety against the disease, proper follow-up measures should be taken and vaccination should be repeated every six months or annually in order to protect all new arrivals and unvaccinated birds.

In order to distinguish the vaccinated birds from the rest some identification mark is necessary. For this, toe-punching, or slitting the web of a foot with a small pair of scissors, or snipping off the last phalanx of a toe with a nail clipper should be done after vaccination. By slitting one web or by snipping off the phalanx of one toe after each vaccination a progressive record will be maintained easily. For example, the birds vaccinated during 1956-57 are identified, say, by slitting the edge of the outer web or snipping off the phalanx of the outer toe of the right foot. During the follow-up operation after six months only birds and new chicks over six weeks or two months old are vaccinated and are identified by slitting the inner web or snipping the last phalanx of the middle or outer toe of the right foot. Similarly, during the subsequent follow-up operations the outer and inner web, respectively, of the left foot may be slit or the phalanges of the corresponding toes snipped off. This will also help in keeping a record of the age of the birds and the duration of immunity.

The mass vaccination campaign launched in one of the States in the country has made it possible to avert further outbreaks of the disease in the State. During the first year of the campaign as many as 24 lakh birds out of a total poultry population of nearly 35 lakhs were vaccinated, and 50 to 90 per cent of the birds in the villages were protected. In the second year, the campaign was extended to the remaining villages and simultaneously follow-up operations were undertaken in the villages already covered and the unvaccinated birds and new arrivals were protected. As a result of this systematic drive, the disease was virtually eradicated, whereas previously one or even two annual visitations of it were not uncommon. The vaccine used was the *chick-membrane wet vaccine* prepared locally by the State Government Biological Institute. Arranging continuous supply to the field workers of this highly perishable vaccine as well as of the ice required for its preservation was the most difficult part of the campaign. For this, vaccine depots or centres were opened at all the district headquarters and at such other places where refrigerators were available, and vaccine and ice were supplied from there. Now that a stabler freeze-dried vaccine is available at the Indian Veterinary Research Institute, Izatnagar, and also at the Biological Institutes of some of the States, the question of transport of the vaccine over long distances should present little difficulty.

Fowl Pox. Fowl pox is a highly contagious and infectious disease of chickens caused by a virus. It affects birds of all ages, but young chicks are more susceptible to it and succumb at once.

Symptoms: The disease occurs in three forms, namely (1) the skin or the cutaneous form (Fig. 108) in which the birds show wart-like nodules on the unexposed parts of the body, particularly the head; (2) the buccal or the mouth form (Fig. 109)

in which yellowish cheesy membranes are formed in the mouth; and (3) the oculonasal form (Fig. 110) in which both the eyes and nasal cavities are involved, which in advanced stages of the disease get occluded by muco-purulent cheesy yellow pus. The last two forms are also called avian diphtheria or canker.

Prevention and Control: An efficient vaccine is now available which consists of fowl pox virus cultivated on the developing chick membrane. The vaccine should be used only on chicks aged over eight weeks, as younger birds if treated with it are likely to develop a generalised pox. In case it becomes necessary to vaccinate the younger stock at the time of an outbreak, only vaccine prepared from the pigeon pox strain of the virus should be used. The immunity given by the pigeon pox virus is neither firm nor lasting, but all the same it is good enough to tide over the immediate danger of an outbreak. In order to make the immunity more lasting, the chicks should be revaccinated after about three weeks or a month or when they are eight weeks old.

Treatment: It is generally not wise to treat the affected birds, especially those showing the buccal (mouth) and ocular forms. The skin form can be treated by first removing the crusts and then touching the sores with silver nitrate sticks or with a saturated solution of picric acid, followed by an application of corbolated vaseline (10 per cent).

Tick Fever (Spirochaetosis). Tick fever is a septicaemic condition caused by a cork-screw shaped organism known as *Borrelia gallinarum*, which is present in the sick birds during fever. The disease is transmitted from the sick to the healthy birds by the common fowl tick *Argas persicus*. Tick fever is of no less importance than Ranikhet disease, especially in the northern and central States of India, where it causes widespread and heavy losses.

The disease is markedly absent in most of the southern States, because of the absence of the vector tick. In order to keep these regions free from the disease, it is of utmost importance that all the birds obtained from outside areas should be free from ticks when they arrive.

The incidence of the disease is at its worst during summer and early autumn, when the season is favourable for the multiplication and activity of the ticks.

The first symptoms of the disease are loss of appetite, increased thirst, ruffled feathers and high fever, the temperature rising up to 110° F. The bird assumes a crouching appearance with its neck retracted and the head either bent downward (Fig. 111) or hidden under the wings. Next follow a greenish foetid diarrhoea, paleness of comb and wattles, disinclination to move, and progressive paralysis of legs and wings. Death occurs in three to ten days. The mortality is high, and may range from 76 to 100 per cent.

Prevention and Control: Prevention of the disease consists in keeping the premises free from ticks. This is by no means easy, especially under the village conditions, although daily cleaning of poultry houses, occasional disinfection, and provision of tick-proof perches may help in the elimination of the vermin.

Active immunisation of the birds can be achieved by first injecting the healthy stock with 0.3 cc. of blood containing spirochaetes from an infected



FIG. 106. BIRDS BEING VACCINATED AGAINST RANIKHET DISEASE



FIG. 107. PARALYSIS OF LEGS AND WINGS FROM RANIKHET DISEASE



FIG. 108. CUTANEOUS FORM OF FOWL POX SHOWING ERUPTIONS ON THE COMB

bird, and then by giving an intra-muscular injection of Sulpharsenol, 36 to 48 hours later, at the rate of 1 cg. per pound of body-weight. A 2 per cent solution in sterile distilled water is employed for this purpose. This treatment gives protection against the disease for about six months.

All newly purchased birds should be examined for seed ticks on the body. These can be eliminated by dusting them with a reliable insecticide such as DDT, Gammexane, Hexydan, etc.

Treatment: In the earlier stages the disease is amenable to treatment with Soamin and Sulpharsenol in doses of 2 cg. and 1 cg., respectively, per pound of body-weight. These should be dissolved in 1-4 cc of distilled water and then injected, preferably into the breast muscles. Sulpharsenol is less toxic and therefore safer to use.

During an outbreak all birds should be promptly treated with Sulpharsenol, as it not only cures the affected ones, but also offers temporary protection to non-infected birds.

Infectious Coryza. This is a very serious disease of the chickens characterised by the inflammation of the sinuses of the head and upper respiratory passages. Young chicks up to four months of age are usually affected and mortality is high. Older birds may also be affected, and the layers rendered uneconomical.

The disease seems to have a regional and seasonal incidence. Low-lying areas, moist clay soil, dampness, heavy rainfall and insanitary environments offer favourable conditions for its onset and spread. Birds with heavy worm burden seem specially susceptible to it. It is rather uncommon among the *desi* breeds.

Symptoms: The disease starts with a watery discharge from the nostrils and eyes, (Fig. 112). The inflammation extends to the upper respiratory passages and air sinuses, and the nasal discharges become muco-purulent. The eyelids get glued together, a cheesy mass of pus accumulates between the eyelids and the eyeball affecting one or both the eyes (Fig. 113), and considerable respiratory distress ensues (Fig. 114). The birds are unable to see and feed. Emaciation soon sets in followed by death, the course being usually a prolonged one extending in some cases to several weeks.

Treatment: Treatment is of no avail. Also, no specific preventive measure is known. The general preventive measures recommended earlier are the only known means of minimising the incidence of the disease.

Avian Leucosis. Avian leucosis or fowl paralysis is a disease introduced into India in recent years following the import of poultry from abroad. It is confined mostly to the organised farms, but the indigenous (*desi*) birds are equally susceptible to it if raised in association with the infected stock. The cause of the disease is a virus affecting different organs or tissues of the fowl.

Symptoms: The symptoms of the disease vary according to the organ or tissues (liver, lungs, heart, kidneys, ovary, oviduct, spleen, intestines, nerves, eyes, skin, blood and bones) affected. Lameness, irregular gait, paralysis, heart failure, respiratory distress, digestive disorders, blindness, gray or pearl eyes, anaemia, tumours, and thickened or swollen bones are common manifestations. Figures 116-

122, 125, 126 show some of the symptoms of the disease and the pathological conditions of the organs or tissues involved.

There is no treatment for the disease. The following preventive measures should, however be taken: (1) Birds showing any manifestation of the disease should be culled; (2) breeding stock should be carefully selected from birds which have shown resistance to the disease; (3) chicks should be raised separately from the adult stock; and (4) cleaning and disinfection of poultry houses, utensils and equipment associated with affected birds should be undertaken.

Fowl Cholera. The disease is rare in India. It is mentioned here because it is being generally confused with other poultry diseases of which diarrhoea is one of the symptoms. Particularly Ranikhet disease, which has as one of its symptoms a greenish yellow diarrhoea is often mistaken for fowl cholera by the flock owners and at times even by inexperienced veterinarians. It has been observed that very frequently measures are also taken for protecting the birds against fowl cholera, without taking the simple precaution of getting the diagnosis confirmed in a laboratory. The result of such preventive measures is too obvious to need elaboration, bringing only discredit to the organisation and the measures adopted.

Symptoms: Fowl cholera is a septicaemic disease which may be suspected when birds are found dead in their houses or coops without any previous signs of ill-health. Its cause is a bacteria known as *Pasteurella aviseptica*. Post-mortem examination shows haemorrhage under the inner lining of the heart and intestines. The liver, spleen, kidneys and the heart-sac are also inflamed. The laboratory diagnosis of the disease is easy, and should be done whenever there is any doubt.

Treatment: The progress of the disease being very rapid there is hardly any time for treatment. Only preventive measures can be taken to keep it from spreading. Prevention consists in observing the accepted principles of sanitation and inoculating all the birds exposed to infection, with fowl cholera serum, followed after a week or ten days by vaccination with fowl cholera vaccine. The immunity is temporary and lasts only for the season.

Tuberculosis. It is a highly infectious disease caused by the bacteria *Mycobacterium tuberculosis* (avian strain).

Symptoms: The affected chicken generally 'goes light' and has little or no flesh on the breast bone. The comb and wattles are pale, and in the final stages of the disease there is paralysis and lameness of the legs. A post-mortem examination of the carcass reveals greyish-white nodules varying in size from a pin-head to a pea on the liver, spleen, intestines and lungs.

Treatment: There is no treatment for the disease. The birds harbouring the infection should be detected as early as possible by subjecting the entire flock to tuberculin test, and destroyed.

DISEASES CAUSED BY PARASITES

The climatic conditions of the country are favourable to the propagation of poultry parasites. The important parasites may be classified as follows:

- (i) Protozoan parasites

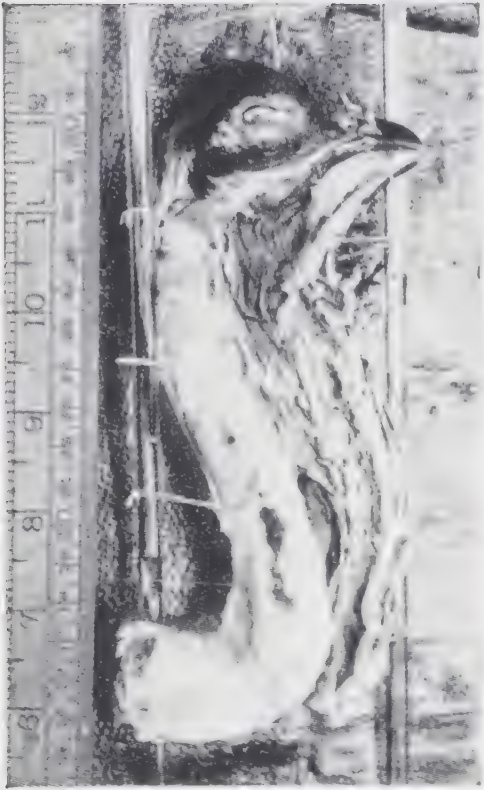


FIG. 109. BUCCAL FORM OF FOWL POX SHOWING CHEESY MEMBRANES IN THE MOUTH AND TRACHEA



FIG. 110. OCULONASAL FORM OF FOWL POX -HEAD OF A DEAD BIRD SHOWING INVOLVEMENT OF THE EYE AND NASAL CAVITIES



FIG. 111. SPIROCHAETOSIS AILING BIRDS



FIG. 112. CONTAGIOUS CORYZA—HEAD OF AN AILING CHICK SHOWING INVOLVEMENT OF NOSTRIL AND EYE



FIG. 113. CONTAGIOUS CORYZA—HEAD OF AN AILING FOWL SHOWING A CHEESY MASS OF PUS UNDER THE EYELIDS AND IN THE NOSTRIL

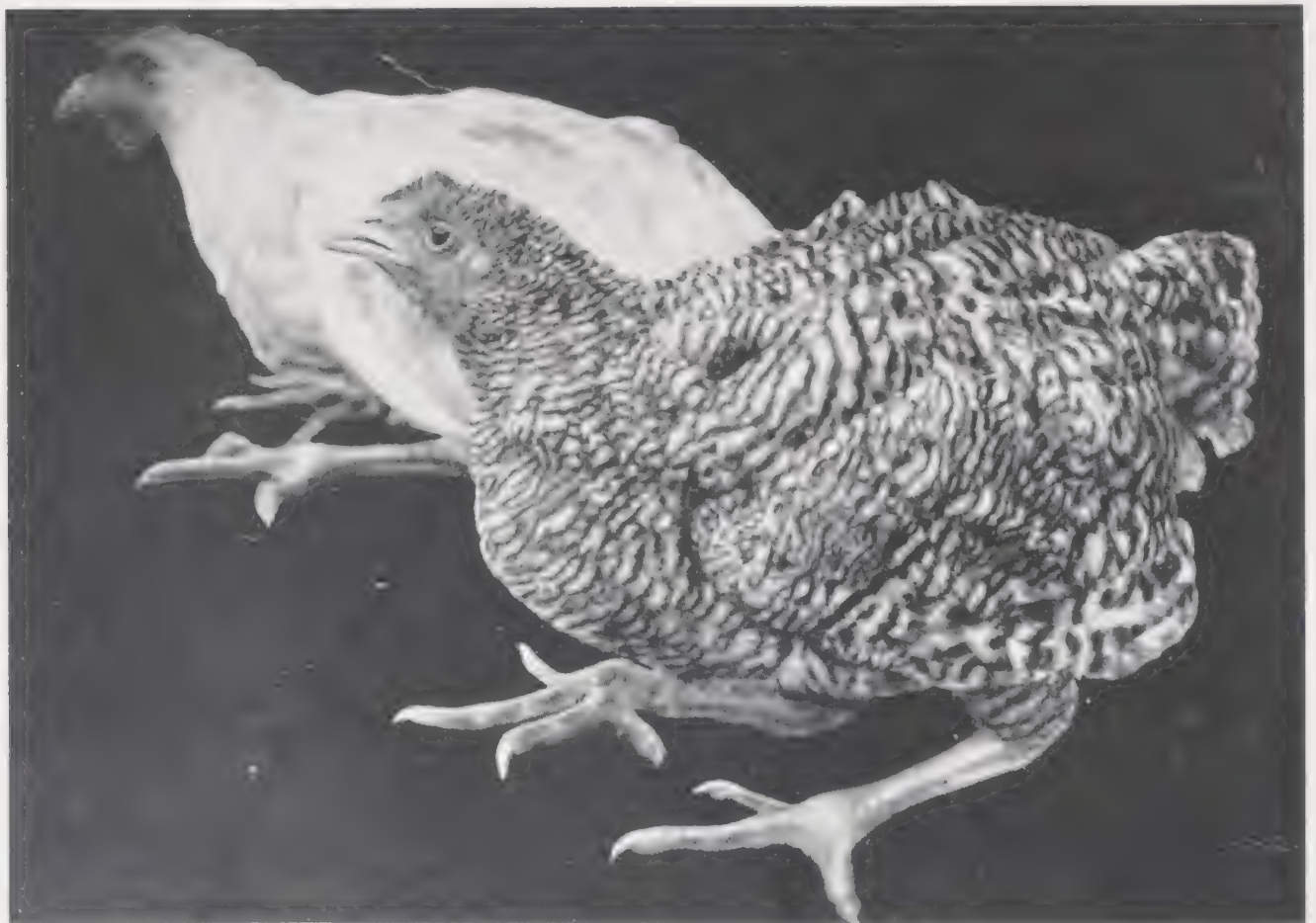


FIG. 114. CONTAGIOUS CORYZA—CHICKS SHOWING SYMPTOMS OF RESPIRATORY DISTRESS

- (ii) Internal parasites or helminths or worms
- (iii) External parasites

The diseases caused by these parasites are dealt with below:

PROTOZOAN PARASITES

The *Coccidia* of the Protozoan group cause a severe disease condition known as Coccidiosis, which causes heavy losses to the poultry industry. In the case of young growing birds, it lowers vitality, retards development, delays egg-laying, and causes even death. In the laying flocks it invariably brings down egg production.

The organisms which cause coccidiosis are small microscopic single-celled animal parasites of the lowest order of life. There are eight different species which affect chickens. Of these, two are more deadly than the rest. One of them, *Eimeria tenella*, affects the caeca of chickens (Fig. 127), producing the commonly

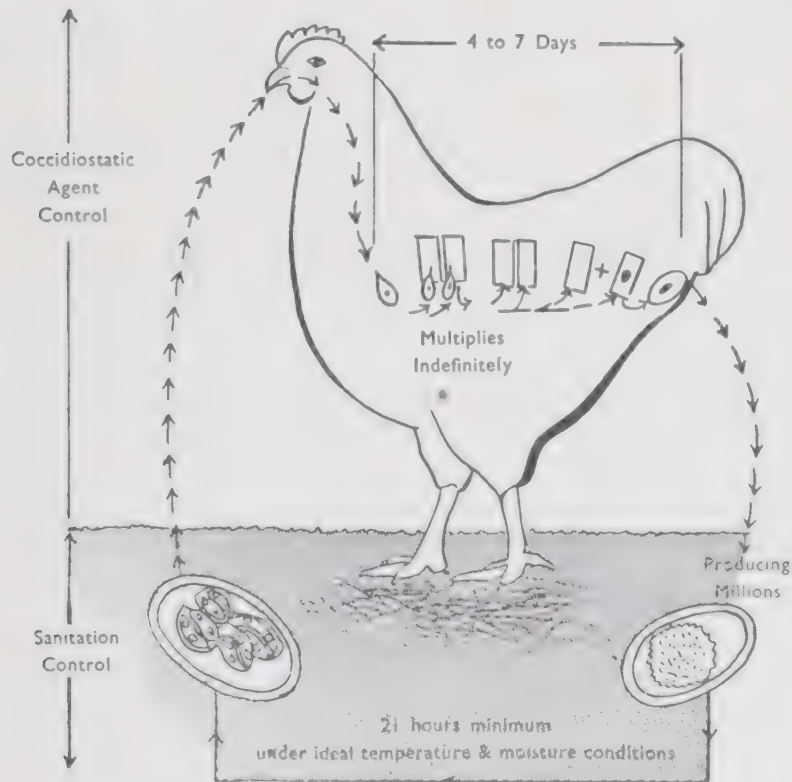


FIG. 115. LIFE-CYCLE OF COCCIDIA

encountered type of the disease known as caecal coccidiosis. Young chicks of three weeks to four months old are the usual victims. Another species, *Eimeria mitis*, attacks the anterior portion of the small intestines (Fig. 128) of adult birds generally.

Chickens contract coccidiosis when they are raised in contaminated houses, sun porches, yards and ranges. Contamination may occur from one or more of the following sources:

- (1) From droppings of chickens that contain the oocysts of coccidia.
- (2) From coccidia that are carried mechanically by other birds or animals or by attendants or visitors.

(3) From poultry manure in the yards or ranges.

Life-cycle of Coccidia. The life-cycle of coccidia is a complicated one (Fig. 115). When a sporulated oocyst in its infective stage is eaten by a susceptible chicken, each of the eight infective organisms contained in it penetrates a cell in the intestinal lining. Each of the infective units multiplies 16 times and gets liberated by rupturing the cell, when 16 more cells of the intestinal wall are attacked. The multiplication proceeds continuously, until at some undetermined stage instead of further multiplications, male and female organisms are produced. These unite to produce the oocysts which find their way out with the droppings. The oocyst is resistant to heat and disinfectant and can survive for many years in the soil or brooder house. When freshly voided the oocyst is not infective, but under suitable temperature and moisture conditions it would sporulate in about 21 hours and become infective.

(i) *Caecal Coccidiosis*: It is a fatal disease. However, those that survive its attack usually recover in a short time. The symptoms and lesions include bloody droppings, pale face and shanks, bloody vent, caeca enlarged and distended with blood or with yellowish grey, cheese-like cores and sudden death. In advanced stages listlessness, drooping wings, ruffled feathers and unsteady gait are observed.

(ii) *Intestinal Coccidiosis*: Intestinal coccidiosis may result from one or more of the seven species of coccidia already referred to. The most pronounced symptom produced by all these species is paleness. The beak and shanks become pale or white in colour. The lesions and the site affected depend upon the species involved.

Correct diagnosis of both types of the disease would be possible by observing the symptoms and determining the presence of oocysts in the droppings by microscopic examination.

Treatment: There are three methods of controlling coccidiosis (1) proper sanitation, (2) prophylactic use of coccidiostatic drugs, and (3) treatment of the disease.

Sanitation: Sound hygienic measures coupled with good range management would reduce the chances of infection materially. The floors of poultry houses and the equipment used for rearing the birds should be cleaned periodically by scrubbing them thoroughly with hot lye solution. If chicks are raised on wire-mesh floors and, when grown up are let out on a fresh range where poultry had not been kept before or which had been dug up and cultivated, the danger of infection can be averted.

Prophylactic Use of Coccidiostatic Drugs: Coccidiostatic drugs like certain sulpha drugs are included in the poultry feed and water when an outbreak of coccidiosis is apprehended. The drugs inhibit the multiplication of the disease-producing organisms in the birds and thus help them develop immunity.

Treatment: Treatment of the affected flocks with sulpha drugs offers the best promise of relief. Sulphamezathene and sulphaquinoxaline, administered to the ailing birds for three to seven days with drinking water or dry mash at the rate of half per cent check the infestation when given in early stages. Sulphaquinoxaline is generally recommended in preference to the other sulpha drugs on account of its

low toxicity. Indiscriminate use of the drugs, especially, in large doses, is harmful and is, therefore, to be eschewed.

Considerable work has been done in recent years on controlling coccidiosis with the help of medicines. It has been shown that if an infestation can be controlled, the birds will develop immunity against the particular species of coccidia involved.

In experiments with the deep litter system of poultry keeping, it has been found that as long as the litter is dry, this system effectively reduces the number of oocysts. On the other hand, a high percentage of moisture in the litter favours an increase in their numbers. Heaping up the litter in a deep layer so as to develop in it a temperature of 125°F or more, or use of ammonia in the dry litter would be effective in destroying coccidial oocysts.

INTERNAL PARASITES

Internal parasites or helminths, or 'worms' as they are popularly called, comprise three groups of parasites, namely, flatworms, roundworms, and tapeworms. These are described below:

Roundworms. As the name implies, these parasites are cylindrical, 2" to 5" long and of about the thickness of a lead in a pencil. Their eggs, unlike those of the tapeworms, are deposited inside the chicken and passed out with the droppings, they may later be picked up by other chickens which would also become infected. (Plate 4b). Three species are common, viz., large and small roundworms and caecal worms. They are found much lower in the intestines than the tapeworms. Sometimes they accumulate in such large numbers that the lumen of the intestines is blocked. They are not attached to the intestinal wall.

Large Roundworms: The large roundworms, *Ascaridia galli* may be four or five inches long, and can be easily seen on opening the intestine. Under favourable conditions their eggs, voided with the droppings, become infective in about two weeks. The chicks swallow these eggs with their feed and water, and the disease thus goes on spreading.

Caecal Worms: *Heterakis gallinae* a common roundworm, is found in the caeca or blind guts of the chicken. It is about $\frac{1}{2}$ " long.

Caecal worms are themselves harmless, but they serve as carriers of the disease 'Blackhead,' and hence the danger from them. Control measures should include good sanitation and use of phenothiazine, once every four to six weeks, which is very effective in expelling and killing these worms.

Treatment: A single dose of 0.5 gm. of phenothiazine for an adult fowl, and half the dose for the young stock below three months of age administered orally in pill form will help eliminate most of the worms. The treatment may be repeated after five or six months.

When an entire flock of birds has to be dewormed, this method of individual treatment is impracticable. A more satisfactory method of mass treatment consists in feeding the whole flock for a period of about one month with poultry mash mixed with tobacco dust at the rate of 1 pound of tobacco per 50 pounds of feed. This

method obviates the necessity of handling each bird separately; and although the treatment may not be as effective as medication of individual birds, it will provide substantial relief all the same.

Tapeworms. Tapeworms are white, ribbon-like segmented worms which, unlike the roundworms, are not free in the intestines but are attached to the intestinal wall (Fig. 130) by means of hooks with which the heads of most of the species are armed. There are several species which infest chickens. They vary widely in length, the smallest species ranging from about 1-16th to 1-8th of an inch and the largest measuring from eight to ten inches.

Tapeworms are generally found in the upper one-third portion of the chick's intestinal tract. They differ from the roundworms in that their eggs cannot directly infest a healthy bird (Plate 4a). They are ingested first by an intermediate host, such as beetles, snails, slugs, earthworms, lice, flies, etc., which when eaten by healthy birds, cause the worms to develop inside their bodies.

Symptoms: The general symptoms produced by both roundworms and tapeworms are almost identical. The birds become thin and emaciated, and in advanced cases they are literally reduced to 'skin and bones.' The parasites not only deplete most of the food taken by the birds but also produce toxins harmful to them. Besides they cause a constant irritation and mechanical obstruction in the intestinal tract. In the advanced stages of infestation, lameness, leg weakness, and paralysis may also be observed. The appetite remains good and there is usually no noticeable diarrhoea. The effects of the parasites, including mortality, are more marked in the younger birds than in the adults.

Prevention and Control: The losses resulting from the infestation can be prevented by eliminating the conditions which favour worm propagation and ingestion. Sanitary and hygienic measures are the most essential requisites. The presence of worm infested birds in a flock is a reflection on management practices.

When most of the flock is infested, the premises are literally strewn with worm eggs. Sanitation should be regarded as the principal means of parasite control. Special care should, therefore, be taken for: (1) frequent removal and proper disposal of droppings from the poultry house; (2) filling up or drainage of waterholes or wet places to which the chickens have access; (3) periodical change of yards and runs and the ploughing and cultivation of the runs before the birds are again turned in; (4) avoiding close confinement and overcrowding young birds; (5) provision of clean houses and pens, adequate and balanced rations and clean water; and (6) preventing such common vectors as ticks, lice, fleas, flies and snails from gaining access to poultry droppings. The manure heaps should also be sprayed with DDT powder every day after the daily droppings are laid on these.

Treatment: Elimination of tapeworms is much more difficult than that of roundworms, and requires a more drastic treatment. The birds should first be starved for 12 hours. Next, *Kamala* should be administered in pill form in doses of 10 to 15 grains. A combination of uncooked arecanut powder and *Kamala* in the proportion of 1:10 (grains) is found to be more effective.



FIG. 116. AVIAN LEUCOSIS—SHOWING ENLARGEMENT OF THE LIVER

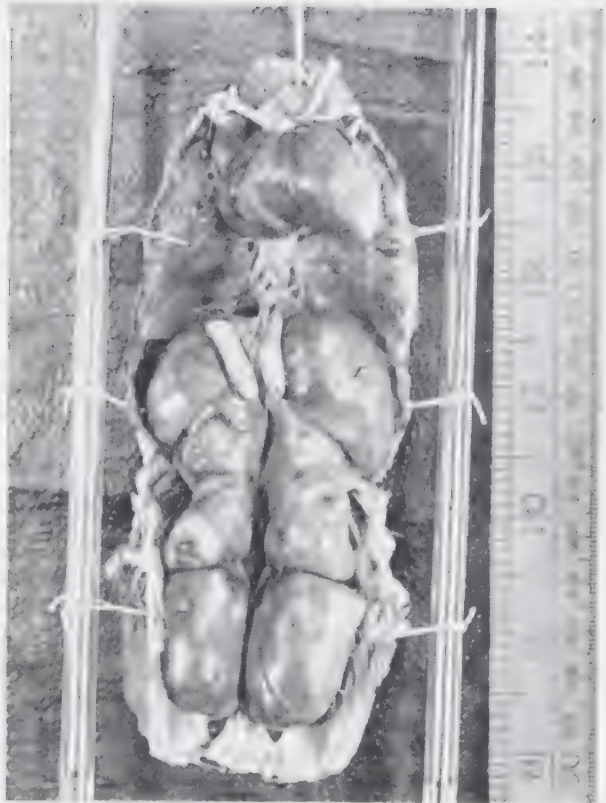


FIG. 117. AVIAN LEUCOSIS—SHOWING INVOLVEMENT OF THE KIDNEYS



FIG. 118. AVIAN LEUCOSIS—SHOWING TUMEFACTION OF THE OVARY AND INTESTINES



FIG. 119. AVIAN LEUCOSIS—SHOWING TUMEFACTION OF THE VISCERA



FIG. 120. AVIAN LEUCOSIS—SHOWING DISCOLOURATION OF THE EYE (PEARLY FOR GREY EYE) AND DISTORTION OF THE PUPIL

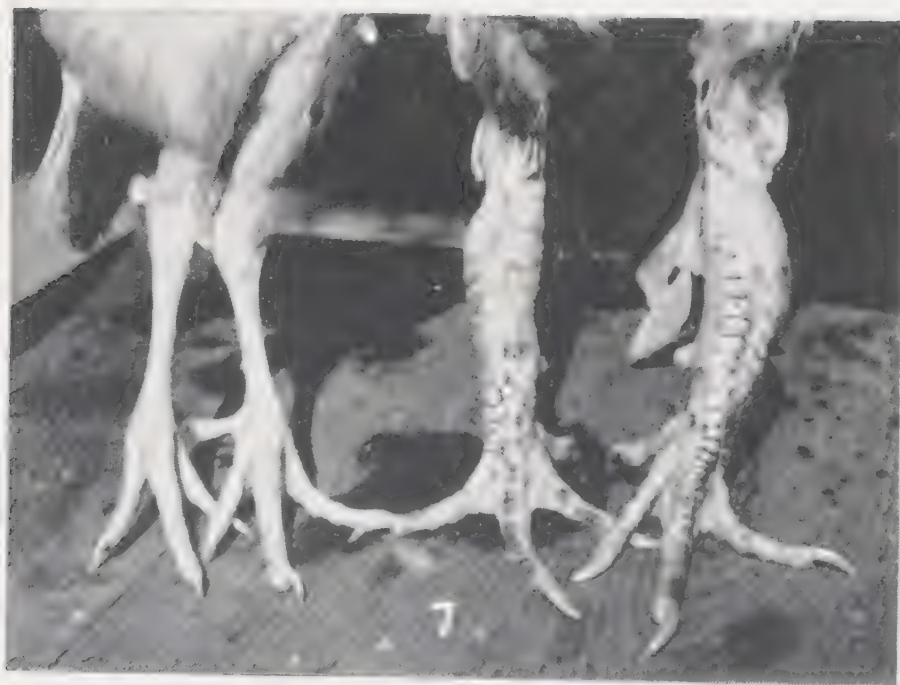


FIG. 121. AVIAN LEUCOSIS—SHOWING THICKENING OF THE LONG BONES (RIGHT) OF THE LEG OF A BIRD COMPARED WITH NORMAL LEGS (LEFT) OF A HEALTHY BIRD

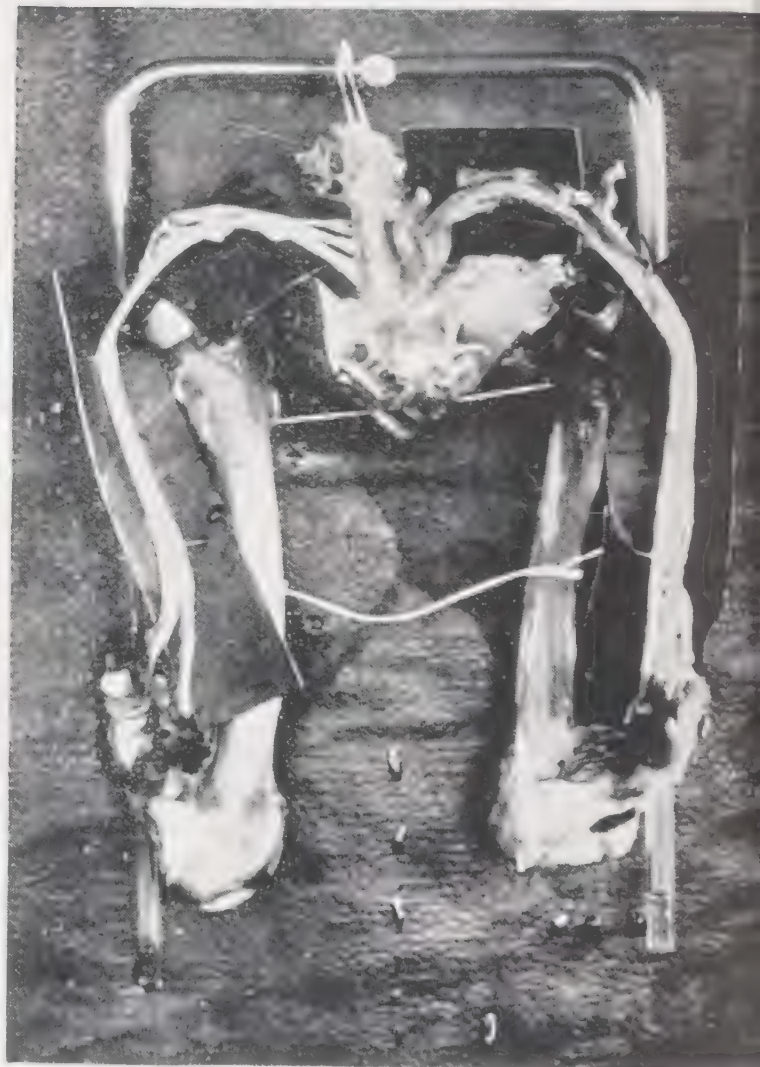


FIG. 122. AVIAN LEUCOSIS—INVOLVEMENT OF THE LEFT SCIATIC NERVE SHOWING THICKENING IN A CASE OF UNILATERAL PARALYSIS (PARALYSIS OF THE LEFT LEG)

EXTERNAL PARASITES

The common external or ecto-parasites are lice, ticks, mites and fleas. They are generally a great nuisance to the birds and also cause enormous loss. The parasites may either remain closely confined to their hosts during the entire life-cycle e.g., lice, and spread only through physical contact, or may wander about freely (e.g., ticks, fleas and mites).

Some external parasites like the fowl ticks and the common red mite attack birds only at night, and remain hiding in convenient shelters during the day. A knowledge of the habits of the parasites and of their life-cycle is, therefore, useful in planning preventive measures against them.

Lice. Lice is the commonest external parasite of poultry. It is a small wingless insect, gray or yellowish in colour, with a body which is flat from top to bottom and possesses blunt heads and six legs. It spends its life on the host bird moving about with absolute freedom. It is very prolific; one pair of lice may produce 1,20,000 young ones within a few months. The propagation is through eggs which are laid on the body and are attached to the feathers in clusters or nests (Fig. 131).

There are two kinds of lice, viz., the body lice and the head lice. The body lice live mostly under the wings and around the vent. The head lice are confined to the head and the neck (Fig. 123).

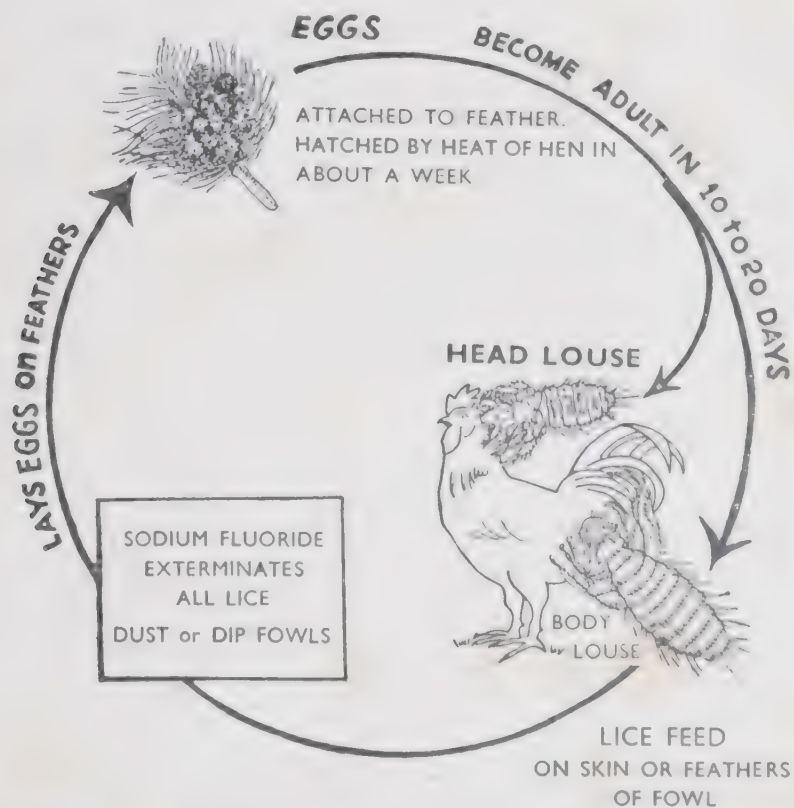


FIG. 123. LICE ON POULTRY: THEIR LIFE-CYCLE AND CONTROL

Symptoms: The lice cause constant irritation to the birds and keep them restless. As a result of this the birds lose appetite, and consequently the egg yield goes down. Young chicks may die of a heavy infestation.

Control and Treatment: A large number of insecticides are available for eradicating lice. Treatment with them should be repeated every ten days till the parasites and their eggs are completely destroyed. Some tried insecticides are given below:

(1) **NICOTINE SULPHATE (40 PER CENT SOLUTION):** It should be painted on the perches at about sunset when the birds go to roost. The fumes emitted will kill the lice. It gives very satisfactory results in summer but is not equally effective in winter.

(2) **SODIUM FLUORIDE SOLUTION:** A solution of $\frac{3}{4}$ -1 ounce of sodium fluoride in one gallon (5 seers) of warm water makes a good bath for the lice infested birds. The birds are held by the wings and dipped leaving the head above the solution. Dipping for $\frac{1}{2}$ -1 minute is enough, at the end of which the head should also be dipped once quickly. The treatment should be given on a warm day.

(3) **DERRIS SOLUTION:** In place of sodium fluoride $\frac{1}{4}$ ounce of Derris may be dissolved in one gallon of warm water, and the solution used for dipping the affected birds.

(4) **DUSTING THE BIRDS WITH ONE OF THE FOLLOWING INSECTICIDES:**

- (a) Hexyclan or Gammexane, one part in 1,000 parts of wood ash.
- (b) DDT, one part in 20 parts of wood ash.
- (c) Tobacco powder one part, sulphur one part, and wood ash 10 parts.
- (d) Sodium fluoride, undiluted.

A pinchful of any of the above should be placed under the wings, below the vent, and on the breast and neck of the bird. Alternatively, the dusting mixtures may be placed in the poultry houses or pens in shallow containers as dust bath.

Head lice are often troublesome. Their eradication is somewhat difficult. They can be killed by smearing sulphur ointment (1 part of flowers of sulphur in 4 parts of lard or vaseline) over the affected parts.

Ticks. The fowl tick (*Argus persicus*) is a pernicious parasite found throughout the country excepting the South. It not only sucks blood causing anaemia in the birds, but also transmits tick fever (Spirochaetosis) to them.

The tick is nocturnal in its habits and very tenacious. It can live without feeding for nearly three years. It is comparatively more active and abundant during the spring and summer months. The infestation generally occurs either when the birds are placed in tick infested houses or when an infested bird is introduced into the flock.

Prevention and Control: Tick-proof perches should be provided in the poultry houses in areas where tick menace and spirochaetosis are serious problems. This

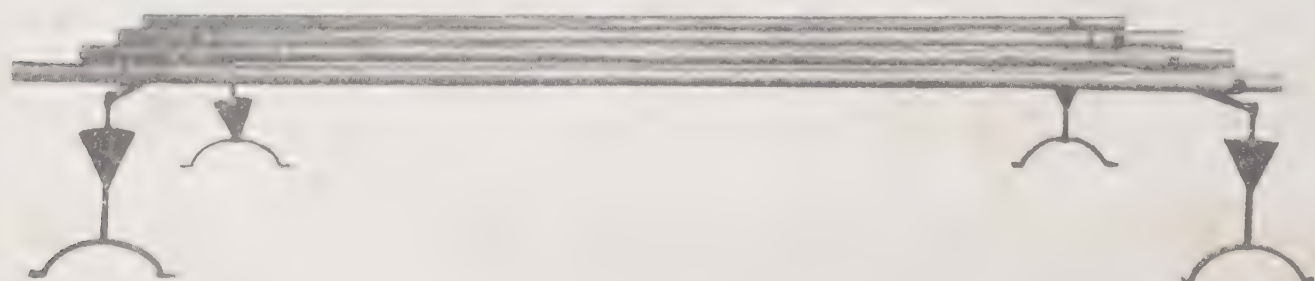


Fig. 124. TICK-PROOF PERCHES



FIG. 125. AVIAN LEUCOSIS--SHOWING PARALYSIS OF RIGHT LEG



FIG. 126. AVIAN LEUCOSIS--SHOWING PARALYSIS OF BOTH LEGS



FIG. 127. COCCIDIOSIS (CAECAL TYPE)—SHOWING THE INVOLVEMENT OF CAECA



FIG. 128. COCCIDIOSIS (INTESTINAL TYPE)

can be done by fitting a metallic cup (Fig. 124) on each of the vertical supports of the perches and filling the cups with water having a thin layer of kerosene oil on the top. The ticks that crawl up the supports to reach the birds will get entrapped in the cups and perish. Alternatively, the perches may be suspended from the roof by means of wire, and metallic cups containing water and kerosene fitted on the suspenders.

The birds infested with seed or larval ticks should be treated with 5 per cent DDT dust or Gammexane, 1:1,000 in water or dust. Both these insecticides kill the larvae. A mixture of kerosene oil in *sarson* or *neem* oil (1 in 4 parts) or methylated spirit if applied to tick infested parts of the bird will also loosen the hold of the larvae, which can then be removed with a piece of cotton-wool or cloth.

Eradication of adult ticks from poultry houses is a difficult problem because of the impracticability of reaching every crack or crevice in the house with insecticides. The best way of destroying the ticks is to apply direct flame to the house components. This can, however, be done only if the walls, roof and equipment of the house are of non-inflammable materials. Houses constructed with angle iron frames and cement asbestos sheets would enable the flame treatment to be carried out without difficulty. A blow pipe or aerosol burner can be used for the purpose.

Houses made of wood and brick should be sprayed or washed with the following emulsion after thorough cleaning:

Soap ..	..	1 part
Kerosene oil ..	..	3 parts
Phenyl ..	..	3 parts
Hot water ..	..	93 parts
Total ..	..	100 parts

The emulsion should be used while hot. In the case of mud houses and thatched roofing tick eradication is still more difficult. It is better to remove the birds to a new house during the day time and to burn down the old house.

Mites. Mites attacking poultry are generally small in size, and have four pairs of legs as against the three pairs possessed by the lice. Three different species of poultry mites are commonly found in India. These are—red mites, scaly-leg mites, and depluming mites. Measures to be taken for their control and eradication are discussed below:

Red Mites: The red mite, or as it is also called the roost mite, has habits similar to those of the ticks. It spends most of its time in the cracks and crevices of poultry houses and attacks birds only in the dark. The measures for controlling and eradicating red mite are, therefore, the same as those recommended for ticks (Fig. 129).

Scaly-leg Mites: The scaly-leg mite is a very small insect and cannot be seen readily by the naked eye. It burrows itself under the scales of legs and causes

inflammation and swelling (Fig. 132), the condition being known as scaly-leg. The older birds are generally affected.

Treatment consists in dipping the legs in either crude petroleum or a mixture of used crank case oil and kerosene in equal parts (Fig. 133). The treatment should be repeated after a month if necessary. Care should be taken not to spill the oil on the feathers or skin as it causes blisters. Treatment should be done in the morning so that the legs are dry before the birds roost.

Depluming Mites: The depluming mite is also too small to be seen by the naked eye. The mite burrows itself into the skin, and lives near the base of the feathers. The intense itch or irritation produced by it causes the bird to peck at its feathers.

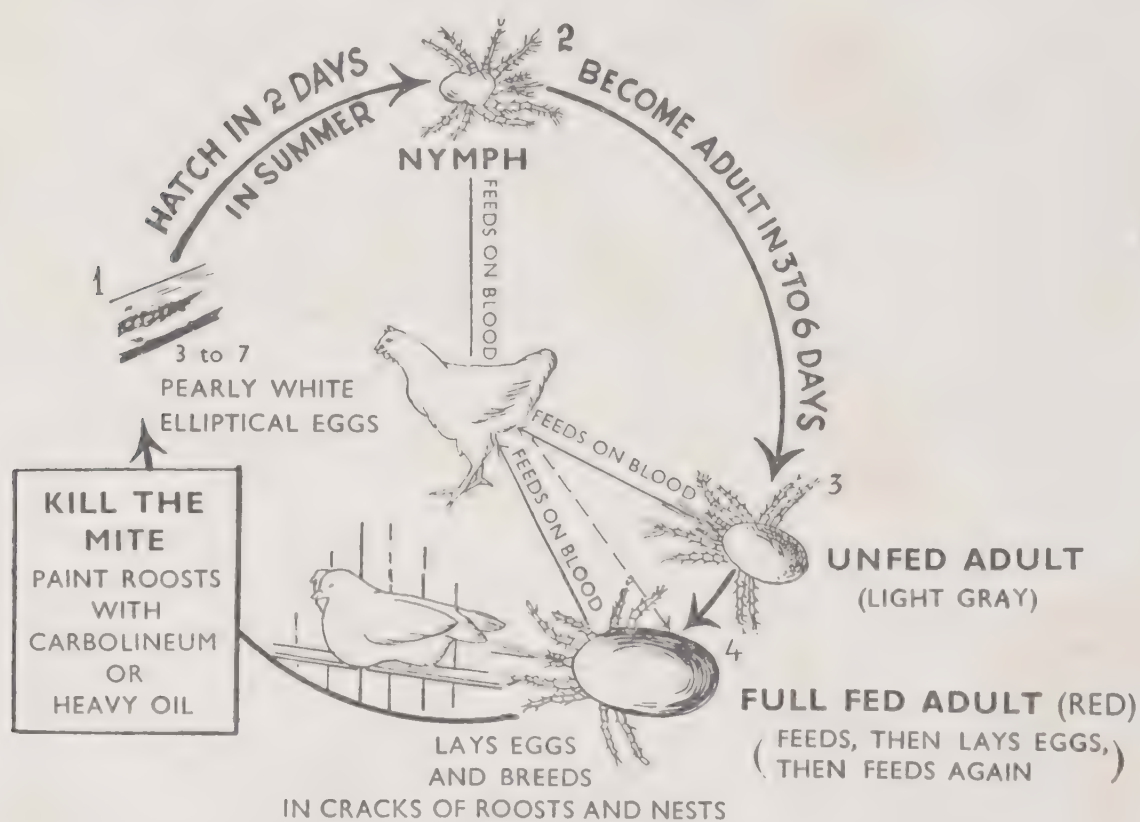


Fig. 129. RED MITE OF POULTRY: ITS LIFE-CYCLE AND CONTROL

Treatment consists in smearing the affected parts with an ointment containing 1 part of sulphur and 4 parts of lard or vaseline. In warm weather dipping may also be done in a solution consisting of 3 ounces of sulphur and 1 ounce of soap in one gallon of warm water.

Fleas. Fleas are very small, active, jumping insects with three pairs of legs, and are dark brown or blackish in colour. The body of the flea is flat from side to side.

Three species of fleas generally affect poultry. Of these the stick-tight flea is the most pernicious. The fleas usually attach themselves firmly to the comb, wattles and the area around the eyes of the birds. Heavy infestation may produce death in young chicks, while in adult birds it would impair production and arrest growth.

Prevention and Treatment: As the larvae thrive in the litter, floors, walls, crevices, etc., the poultry house and all the equipment in it should be thoroughly cleaned and sprayed with 5 per cent DDT emulsion or 2 per cent creosote oil. But since spraying would cause dampness, it should be avoided in damp cold weather, especially if the birds are in the house. Another alternative is to use 10 per cent DDT powder at the rate of $\frac{1}{4}$ lb. for every 100 square feet of floor space in the nests. This would give good results.

Treatment consists in dusting the birds with 10 per cent DDT powder or any powder containing rotenone.

DISEASES CAUSED BY FUNGI (MOULDS)

Aspergillosis. Aspergillosis is a disease of the lungs and air sacs, especially in the young chickens in the brooders. It is caused by a fungus, the common green mould (*Aspergillus niger*), found in mouldy hay, chaff and straw. When such hay or chaff is used as litter in the brooder houses or when mouldy grains are fed, the fungus is inhaled and the disease may start.

Symptoms: The usual symptoms are catarrh, accelerated breathing, and a rattling or croupy sound during expiration. The difficulty of breathing progresses rapidly and the birds die of suffocation.

Prevention: Only clean and bright straw and chaff should be used in poultry and brooder houses for litter. The feeds should be free from moulds. The dead birds should be burnt.

Favus (White Comb). Favus is a fairly common contagious disease characterised by grayish-white spot formation on the comb, ear lobes and wattles. It is caused by the fungus *Achorion gallinarum*, and spreads through simple contact.

Symptoms: The disease generally starts on the base parts of the head. Small white or grayish spots are formed which increase in number and size until the whole surface is covered with dry, scaly, dirty white crusts with irregular surface.

Treatment: Application of tincture of iodine or 5 per cent formalin solution to the affected parts is recommended.

NON-INFECTIOUS DISEASES

The losses suffered by poultry from causes other than those dealt with above may be ascribed to non-infectious diseases. These are considered below under main heads, viz., (a) faulty nutrition, (b) unhealthy environmental influences, and (c) disease-promoting genetical factors.

FAULTY NUTRITION

Heavy poultry losses may occur on account of faulty or defective feeding. Both excess or lack of fibre, excess of proteins and grains, and mouldy feeds should be avoided. Soiled table garbage should not be fed without properly cooking it for at least half an hour. Uncooked flesh of dead animals or decomposed offals from wild animals or game birds should not be fed. The feed should contain all the essential ingredients in adequate quantities to meet the requirements of the

birds for normal growth and production. Rickets, nutritional roup, and perosis are deficiency diseases, while obesity and gout are attributed to the feeding of diets containing excessive quantities of certain substances.

Protecting the feed from faecal and other contamination by using properly constructed feed hoppers is necessary. The hoppers should be cleaned at frequent intervals. Sweepings from the floor of the feed house should not be given to the young growing stock. Mechanical mixing of the feeds is preferable to hand mixing, as it not only makes for proper mixing of the ingredients but also reduces the chances of accidental contamination. Excess feed scattered around yards attracts rats, mice and birds which may be potential carriers of diseases. The major diseases caused by faulty nutrition are discussed below:

Nutritional Roup (Vitamin A Deficiency). Nutritional roup is a disease which resembles contagious coryza but is caused by vitamin A deficiency in the diet. Birds of all ages are susceptible to it. It is particularly common during the summer months when sufficient green food is not available.

Symptoms: The usual symptoms of the disease are lameness and staggering gait in the growing birds, and discharges from the nostrils and eyes and swelling beneath the eyes in the adults. Examination after death shows swollen follicles of oesophagus, (Fig. 134); pale kidneys and accumulation of urates in the kidneys and ureters.

Control: Control measures consist in increasing the quantities of fresh green leaves and yellow maize in the feeds and incorporating in them high grade shark liver oil obtained from reliable suppliers. Treatment of severe cases is not worthwhile.

Rickets (Vitamin D Deficiency). Rickets or rachitis is a disease which affects the bones of growing chickens. It is caused by deficiency of vitamin D, calcium or phosphorus. Poor growth, lameness accompanied by a stiff gait, thickened leg bones and hock joints and beading at the end of ribs are the usual symptoms of the disease. Spinal curvature and crooked breast bones may also be seen. A simple control measure is to include bonemeal and oyster shell in the poultry mashes and to expose the chicks to direct sunlight daily. Treatment is of no avail.

Perosis or Slipped Tendon (Manganese Deficiency). Perosis, slipped tendon or 'deforming leg weakness' is a condition that occurs in growing chicks as a result of manganese deficiency. The first symptom to be noticed is enlargement of the hock joints which is followed by a bending of the distal end of the long bones forming the hock joint. This causes the Achilles tendon to slip from the condyles to either the inside or outside of the joint resulting in loss of control over the legs.

Control: Control of the disease consists in prevention rather than treatment. The disease is incurable after the deformity occurs. It is best controlled by including adequate quantities of manganese in the feed. A mixture of 1.7 pounds of anhydrous manganese sulphate and 100 pounds of salt should be prepared. Half per cent of this mixture should be included in the all-mash diets and 1 per cent in the growth and starting diets which consist of grain-mash mixture. By-products



FIG. 130. TAPEWORMS—PARASITES ARE SEEN ATTACHED TO THE MUCUS LINING OF
INTESTINAL WALL



FIG. 131. FEATHER SHOWING EGGS OF COMMON LOUSE (*From 'Farmer and Stock-breeder'*)



FIG. 132. SCALY-LEG



FIG. 133. TREATMENT FOR SCALY-LEG. AFFECTED LEGS ARE BEING
DIPPED INTO A MIXTURE OF USED CRANK-CASE OIL AND
KEROSENE



FIG. 134. NUTRITIONAL ROUP -HEAD OF A BIRD SHOWING CHRONIC AVITAMINOSIS. NOTE THE SWELLING UNDER THE EYE. DISCHARGES IN THE EYE AND NOSTRIL AND SWOLLEN FOLLICLES OF THE OESOPHAGUS WHICH IS SLIT OPEN

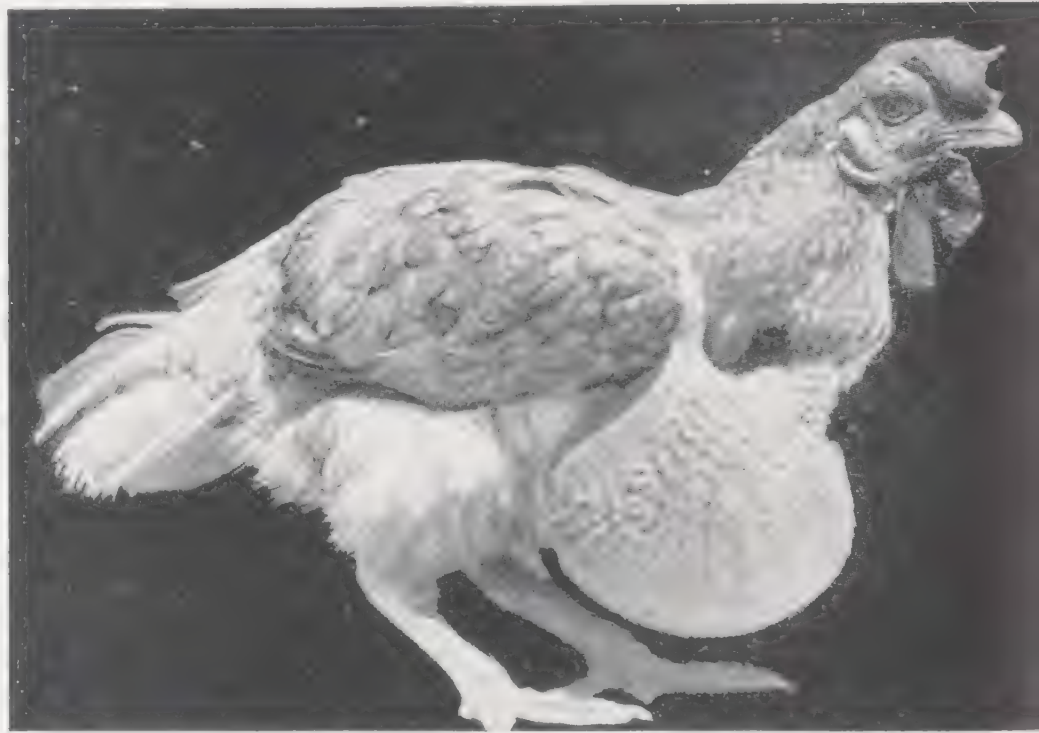


FIG. 135. CROP BOUND - IMPACTED CROP



FIG. 136. OVERTCROWDED CHICKEN YARD

of rice milling such as rice bran are rich in manganese, and when good rice bran forms a part of the mash, addition of extra quantities of manganese is not necessary.

Cannibalism or Feather Picking. The term 'cannibalism' is generally used to describe a habit sometimes developed by poultry of picking one another's feathers, toes, vent, combs and other parts of the body.

Cannibalism and feather picking are probably the result of several causes, such as close confinement, idleness, dietary deficiencies, presence of depluming mites at the base of the feathers, etc.

Treatment: Feather picking and other allied vices can be checked by removing the above causes and by increasing the salt content of the diet for two or three days. If an all-mash diet is being fed, 2 per cent salt is to be added, but if both mash and grains are being fed, 4 per cent salt should be added to the mash. In most cases the effect of this is spectacular and can be seen even within a few hours.

If the salt treatment does not stop cannibalism within 3 days, it may be necessary to trim the upper mandible of the beak of each chicken. This may be done with a sharp knife or a hot soldering iron or a mechanical debeaker. The feeding should be arranged in such a way that the birds get enough to eat and also remain busy scratching for food. Overcrowding should be avoided. The birds should be watched carefully and those found attacking others and the injured ones should be segregated immediately.

Crop Bound (Impacted Crop). An over-distended and paralysed condition of the crop (Fig. 135) is known as crop bound or impacted crop. It is caused by over-eating or by swallowing coarse and indigestible matter such as feathers, straw and feeds rich in fibre.

Symptoms: The crop is very large and highly distended with the contents firmly packed giving it a hard, doughy feel. The bird loses its appetite and if not relieved, dies of starvation.

Treatment: By manipulating the crop and the lower part of the gullet repeatedly, and by administering a teaspoonful of castor oil, the hard mass may be broken up and a good deal of it removed. If this treatment is not successful, the crop may be opened with a sharp knife and the contents removed through the opening. The crop should be then washed with clean warm water and closed with 3 or 4 stitches on both the crop and the skin openings. Ordinary cotton thread will serve the purpose, and application of tincture of iodine to the seat of operation is all that is necessary. The bird should be given only liquid feeds, such as milk and raw eggs, during the first one or two days and then gradually put on soft mash-feed.

ENVIRONMENTAL INFLUENCES

Proper environment is essential for preventing poultry losses. Attention to the sanitation of poultry houses, brooders, etc., will help to prevent several diseases.

Incubator hygiene is particularly essential for preventing chick mortality. Optimum temperature and humidity both in the incubation room and the incubator

are necessary to control embryonic mortality. Besides, the eggs should be placed in proper position, and turned frequently at the time of incubation. Hatching of chicks should be done during favourable times of the year, avoiding, preferably, the hot summer and monsoon periods. The seasons most appropriate for hatching have to be determined with reference to the local conditions of different regions. Eggs set for hatching during summer fail to hatch successfully, while the late-hatched chicks also do not thrive well. Chicks hatched during the monsoon months are predisposed to coryza. It is also necessary to provide adequate shelter for the chicks during summer to protect them against sun-stroke.

Egg-bound. The condition known as 'egg-bound' is frequently observed in pullets when they first start laying eggs. The usual cause is the tempted laying of a larger-sized egg before the egg passage becomes sufficiently dilated to allow egress to it. Inflammation, stricture or tumour formation in the posterior part of the egg passage makes it difficult for the egg to come out and result in egg-bound condition.

Symptoms: The affected hens are restless and visit the nests frequently. They strain hard and persistently to such an extent as to cause prolapse of the oviduct through the vent or cloaca. Other birds may get attracted to the prolapsed mass and start pecking. If the egg is not passed the bird dies ultimately.

Treatment: The most effective treatment consists in removing the egg. This may be done by passing the forefinger through the vent and exerting pressure with the other hand on the abdomen of the fowl to force the egg towards the vent by guiding it with the aid of the inserted finger. When the shell is observed through the vent, it may be punctured with a sharp pointed instrument so as to break it to pieces, which should then be removed piecemeal.

Vent Gleet. Vent gleet is a fairly common ulcerative condition of the cloaca of fowls. Its cause is obscure. The cloaca and vent get inflamed, the skin around the vent becomes swollen, reddened and ulcerated, and a very offensive odour is emitted. The affected bird voids foul-smelling droppings and liquid frequently and with considerable straining.

Treatment: Treatment is ineffective and destruction of the ailing bird is advisable.

Bumble Foot. Bumble foot is the name applied to a swelling or abscess of the foot in fowls. Any bruises or cuts or punctures of the skin of the foot may get infected with germs and lead to this condition.

Symptoms and Treatment: The foot pad is swollen, the swelling extending to and being visible in the interdigital spaces. The birds become lame. The swelling should be lanced and the contents washed if necessary, after curetting the wound thoroughly. The interior of the abscess should then be plugged with either tincture of iodine or sulphanilamide powder and bandaged. The dressings have to be repeated every alternate day until the wound is completely healed.

Subcutaneous Emphysema. The skin of the breast and other parts of the body gets distended with air, giving the bird a peculiar puffed up appearance.

This condition is in all probability the sequel of a rupture of one of the air sacs or other respiratory organ leading to leakage of inhaled air into the spaces

immediately beneath the skin. The condition is also met with as an after effect of a defective caponising operation.

Treatment: No treatment is necessary for mild cases of subcutaneous emphysema as the condition subsides after some time. Very severe cases, if not treated immediately, may, however, cause death on account of suffocation. The only remedy in such cases lies in slitting the skin over the affected area and gently pressing out the accumulated air through the opening.

Heat Prostration (Heat Stroke). Excessively high temperature in poultry houses, which is a common occurrence during the summer, is the cause for heat stroke or heat prostration. Heavier breeds seem to be more susceptible than the lighter ones. The affected birds show accelerated breathing, rise in body temperature (109° - 110° C.), and prostration culminating in death. Trap-nested fowls are often affected because of insufficient ventilation in the nests.

Affected birds should be immersed in cold water. Plenty of shade, good ventilation, abundance of water and ample accommodation in the houses to avoid overcrowding are helpful in preventing heat stroke. Metal sheets should not be used for the construction of trap nests. Frequent letting out of fowls from the nests, especially on hot days, is a desirable practice.

Poisoning. Access to poisonous plants and seeds, rat poisons used for exterminating rats from poultry yards, and lead paint which may be carelessly left about the premises are among the common causes of poisoning in poultry. Sometimes the feed may get contaminated with toxic substances, especially those used as sprays. Heavy mortality may result from such causes.

Prevention consists in avoiding all causes which may lead to poisoning in poultry.

GENETICAL FACTORS

Heredity plays an important role in relation to poultry losses. The modern concept of disease recognises the 'interdependence of three variables—the inherited capacity of the host, the innate characteristics of the disease-producing agent or pathogen, and the environment which may materially influence the interaction of the host and the pathogen'. These implications have to be taken into consideration in any breeding practice aiming at the propagation of highly productive and disease-resistant strains of poultry.

A practical suggestion for achieving this objective from the view point of genetics is (1) the selection of breeding stock for vigour, which means the selection of birds rigidly from the time they are hatched till they are selected as breeders on the basis of all visible signs of vigour, (2) avoiding birds (both sires and dams) whose progeny shows high incidence of mortality due to disease—birds belonging to families or strains in which there has been an appreciable incidence of mortality from any cause.

Tumours. Tumours are frequent occurrences in birds. The incidence of tumours increases with age. The egg-forming organs, and especially the ovary are

more susceptible to tumour formation than other organs or tissues. Tumours are either external or internal. The external tumours are easily recognised while the internal ones can only be inspected when the bird is poor in condition, emaciated and droopy.

Treatment and Prevention: Many of the tumours are malignant in character and it is, therefore, best to kill the bird and destroy the carcass. It has been shown that hereditary predisposition favours the formation of certain types of tumours. It is, necessary, therefore, that families showing greater incidence of tumour formation should not be included in any breeding programme.

MANAGEMENT

SUCCESSFUL poultry keeping is as much a matter of good management as of thorough knowledge of the principles underlying the rearing of poultry and production of eggs. In the preceding chapters the latter aspect has been discussed at length, but a working knowledge of what constitutes good management can be acquired only through actual experience. Certain management practices have already been dealt with in the chapters on Breeding, Brooding and Rearing, Feeding, Housing, Disease Control, etc. In order to emphasize their importance, however, some of the more important points will be recapitulated here.

The subject of poultry management may be divided, for the sake of convenience, into the following sections, (i) general management, (ii) management of chicks, (iii) management of pullets and cockerels, (iv) management of the male birds, (v) management of layers, (vi) management of breeding stock, and (vii) other management problems. These are briefly discussed below.

GENERAL MANAGEMENT

Standard Equipment: Use standardised types of rearing appliances and poultry houses. This helps to economise labour and facilitates easy planning.

Comfort: Provide comfortable accommodation with good ventilation. There should be no overcrowding of birds in the poultry house.

Housing of Growing and Adult Stock: House the growing birds and the adult stock separately. To ascertain the age of the birds adopt toe punching or web slitting when chicks are one-day old. On a farm where part of the laying stock consists of hens retained for a second laying season, separate housing provisions should be made for: (i) growing stock, (ii) pullets in their first year of egg production, and (iii) hens retained for a second laying season.

Portable Houses: Shift the portable houses by about 10 yards every fortnight. Never allow a portable house to remain in one position for more than 4 weeks lest the grass under it should die off.

Semi-intensive Houses and Runs: Allow 3-4 sq. ft. of floor space per bird in the house and 20 sq. yards of run per bird.

Fold Units: A fold of 20' × 5' (100 sq. ft.) is suitable for 25 birds. Such a unit if moved daily will cover in a year 455 sq. yards or 0.938 acre of land.

Perches: Space perches at least 9 inches away from the back of the house. Allow a distance of 12"-14" between the perches, from centre to centre, depending on the breed. Allow at least 7 inches of the perch space per bird of the heavy breeds, and 6 inches per bird of the light breeds.

Nesting Boxes: Provide adequate nesting accommodation. This would vary with the type of the nest used. For example, in the case of trap nests, one nest will suffice for 3 birds, in that of open nests, one nest for 4 or 5 birds, and for commercial nests, one nest of 6 ft. × 2 ft. for every 100 birds.

STOCK

Rearing Chicks. Reserve for chicken-rearing some plot of land near the farm-house which would be used exclusively for this purpose and never occupied by adult stock. One acre will suffice for every 1,000 chickens for the first eight weeks of their life.

Advance Planning. Plan sufficiently well in advance about the general policy to be adopted on the farm regarding the kind of breed or cross to be kept as well as for the supply of day-old chicks.

Raising Chicks by Hatching Eggs. Select eggs from the best layers that are about 1-2 years old, if it is desired to raise chicks by hatching eggs. There is no objection to using younger birds or pullets for breeding except that the physical and other characteristics which justify their inclusion or exclusion for breeding will not have developed, and that the pullets' eggs are generally small.

Collect eggs for hatching a week or ten days after the male bird or cock is put into a pen of hens. Fertile eggs are laid generally for more than a week after the cock has been taken away from the breeding pen, and may be collected for hatching. Select eggs that are of average size (2 ounces), uniform in shape, and with normal shells.

Do not set eggs for hatching which are older than 5 days in the hot season, and 10 days in the cold weather.

FEEDING

Balanced Feed. A balanced feed should consist of grains and mash, or mash alone with the required proportions of carbohydrates, proteins (both vegetable and animal), minerals and vitamins. Depending on the age of the chickens and the purpose for which they are kept, the feed should contain 75-90 per cent carbohydrates, 15-20 per cent proteins, and 5 per cent minerals including 0.5 per cent of common salt. Its fibre content should not exceed 7 per cent while its fat content should be below 5 per cent.

Feed Consumption. Laying birds will eat from 4 to 6 oz. of feed daily, or from 91 to 137 lb. per year. The food requirements of chickens vary with their age and breed. The following are the average feed requirements.

One cwt. (112 lb.) of feed is required by a laying bird for a year: 1/4 to 2/7 cwt. (28-32 lb.) of feed is needed for each pullet from the time of hatching till it

MANAGEMENT

is 24 weeks old; $3\frac{1}{2}$ -4 cwt. (392-448 lb.) of feed will suffice for 100 chickens for 8 weeks from the hatching time. In other words, one ton of feed will suffice for (i) 20 laying birds for one year, or (ii) 80 pullets from hatching to the age of 24 weeks, or (iii) 500 chickens from hatching to the age of 8 weeks.

Water Requirements. Provide plenty of fresh water all the time. The daily requirements of 100 birds are: (i) laying birds: 5-6 gallons, (ii) chicks up to 4 weeks old: about $1\frac{1}{2}$ gallons, and (iii) chickens 4-8 weeks old: 2-3 gallons.

Grit. Keep in open hoppers grit all the time. Grit helps in grinding and digesting the food, and in supplying calcium which the chicks require for building their bones and egg-shells. One hundred laying birds will require annually 2 cwt. (224 lb.) of limestone or oyster shell grit, and 1 stone (14 lb.) of flint grit.

Food Trough Space. The space requirements for 100 birds, when both sides of the trough are available for feeding, are as follows:

				In case of dry mash feed (feet)	In case of a wet mash or grain feed (feet)
Adult fowls	..	..	..	12	33
Chickens 1-4 weeks old	..	..		3	7
Chickens 4-8 weeks old	..	..		6	11
Chickens 8-12 weeks old	..	..		8	17
Chickens 12-20 weeks old	..	..		11	25

MANAGEMENT OF CHICKS

Purchase chicks on the basis of quality, not price. The original cost of the chicks represents but a small part of the investment. Chicks of poor quality are not profitable at any time. Be sure that the chicks are healthy. Know about the breeding of the parent stock, and convince yourself that the birds do not suffer from any disease.

ACCOMMODATION AND VENTILATION

Brooder houses should be well built and large enough to accommodate the chicks. Provide each chick $1\frac{1}{2}$ sq. ft. of space in the brooder house. Avoid overcrowding, and do not brood too many chicks under each hover. Satisfactory results are obtained with groups of 250 chicks or smaller number. The brooding equipment should be in good condition and always clean.

Feed Hoppers and Water Fountains. The number of feed hoppers and water fountains should be regulated according to the growth of the chicks (See under 'General Management').

Adequate Sunlight and Ventilation. Have plenty of sunlight in the houses as it helps in controlling diseases and keeping the house dry.

Free circulation of air is necessary in the brooder house. Roof ventilation in the brooder house alone is not adequate, and provision should be made for fresh air to enter freely. Muslin covered frames if substituted for window glass would solve the problem. These should be removed when weather conditions are favourable.

BROODER HOUSE AND BROODER

Preliminary Preparations. Have brooder house thoroughly cleaned, scrubbed, disinfected, and ready for use 4 or 5 days before starting to brood chickens. Use a good disinfectant for the purpose. The following preparations are suitable: (i) one pint cresol in 4 gallons of water, (ii) one pint formalin in 2 gallons of water, or (iii) one pound chlorinated lime (with 30 per cent available chlorine) in 3 gallons of water. The brooder should also be cleaned, disinfected and set in operation two days before the chicks are put into the brooder house.

Brooder Guard. Provide a guard of solid material around the brooder, 1 foot high and 3 feet from the edge of the hover.

Temperature. Keep the temperature regulated in such a way that it is about 90° F. at the edge of the hover during the first week, and drops to 85° F. during the second week and to 80° F. during the third week. Heat should be discontinued after 4 weeks in hot weather, between the 4th and 5th week in fair weather, and after 6 to 7 weeks in cold weather.

Avoid chilling and over-heating by carefully watching the behaviour of the chicks in the brooder, which is the best indicator of the correct temperature to be maintained. If the temperature is too low, the chicks huddle together in a corner or towards the centre of the hover, and if too high they disperse away from the centre. When the temperature is suitable, they get distributed evenly in and around the hover.

Litter. Provide a suitable litter to keep the floor dry. Wood shavings, chaffed hay or straw, sugarcane bagasse, coffee husk, sawdust, chaffed groundnut husk, and sand can be used. Change the litter at least once a week—and more often if there is contamination or too much moisture.

FEEDING OF CHICKS

Start feeding the chicks immediately after they are put into the brooder house, which is generally about 36 hours after they are hatched. The feed for the first two or three days should be given on clean sheets of old newspapers or paper boards spread out on the floor to prevent the birds from eating the litter. After the third day provide enough hopper space for all the chicks to eat at one time. The very first feed in the brooder should consist of fine sand or finely ground flint or grit and warm water. This should be followed in two hours' time by a suitable dry starter mash.

PROTECTION AGAINST DISEASES AND PREDATORS

Removal of Sick Chicks. Carefully watch the chicks in the brooder

house frequently, and remove immediately those that look dull, droopy, isolated or otherwise sickly. Have the trouble properly investigated.

Do not attempt to treat a sick chick. Many poultry diseases do not lend themselves to treatment, and in fact retention of a sick bird for treatment may cause the disease to spread. Prevention is better than cure. Whenever there is suspicion of an outbreak of disease in a flock, the best thing to do is to seek the help of an expert for diagnosis and advice.

Ranikhet Disease and Fowl Pox. Make it a routine practice to get chicks vaccinated against Ranikhet disease as soon as they are six weeks old, and against fowl pox when they reach the age of two months. The Government Veterinary Department is fully equipped to vaccinate the birds.

Disposal of Dead Birds. Promptly dispose of all dead birds by burning or burying them. They are a source of danger not only to your own flock but also to those of your neighbour.

Clean Range. Every time the chicks are transferred from the brooder house to the ground, use a fresh area where birds have not been put before. The ground should be given rest at least once in a year or two, and ploughed, limed and, if possible, cultivated before the new chicks are reared on it after the old flock has gone.

Visitors. Keep visitors away from the brooder house and rearing yards, if possible. Disease germs may be conveyed from one place to another through the clothes, hands and feet (shoes) of the visitors. Before entering the brooder house or the rearing yards the farm staff should dip their shoes or feet in a disinfectant (solution) that should be placed at the entrance. On a farm it is advisable to provide residential quarters to all the staff including the *mazdoors* to avoid any risk of infection from outside.

Predators. Protect chicks from their natural enemies like the crow, hawk, kite, cat, fox, rat, snake, mongoose, etc. by housing them suitably and covering the top of the chicken run with wire mesh.

THE FLOCK

Separation of Sexes. Separate cockerels and pullets as soon as the sexes can be recognised.

Separation of Chicks. Do not keep young chicks with the older birds. Many diseases spread through such contacts, because the older birds may harbour disease germs without showing any outward symptoms.

Size of Flock. Do not start with too many chicks. There is a limit to the amount of work which can be handled satisfactorily. Chicks require careful attention. A small flock well cared for will give better returns than a large one that has been neglected. A flock reared under the personal care of the keeper proves more remunerative than the one entrusted to servants.

MANAGEMENT OF PULLETS AND COCKERELS

The management practices listed above, are applicable equally in the case

of pullets as well as cockerels. In addition, there are certain other special considerations that have to be borne in mind while dealing with pullets and cockerels. These are given below:

1. GIVE PULLETS A FAIR CHANCE

- (a) Separate the cockerels as soon as they can be recognised.
- (b) Train the pullet chicks to roost early—leghorns at 4 to 5 weeks of age, and heavy breeds at 5 to 6 weeks of age—and extend the roosting space to cope with their growth.
- (c) Do not allow pullets to roost on trees growing on the range.

2. PREVENT CANNIBALISM

- (a) Avoid overcrowding in the houses and rearing yards, and also while feeding the birds.
- (b) Let the growing pullets go outdoors early.
- (c) Make the green feed available all the time; avoid tough green feeds; and keep the green feed in covered hoppers or racks in the yards.
- (d) Extend the accommodation and increase the utensils as the pullets grow. A pullet of eight weeks of age is nearly twelve times as big as a day-old chick.

3. FEED PULLETS WELL

- (a) Provide at least 16 feet of eating space at the mash hoppers for every 100 pullets.
- (b) Keep a fresh supply of mash available in hoppers all the time.
- (c) Feed the growing pullets all the green feed they will eat. As maturity approaches, the rate of growth diminishes and so does the protein requirement. The proportion of grain to mash should, therefore, be increased until it is 1:1 at the time the birds start laying. It will also reduce the feeding cost and produce better pullets.

4. MOVE PULLETS TO LAYING HOUSES

- (a) House pullets just before they are ready to lay. Before putting them in the laying houses cull all the undesirable and below standard birds.
- (b) Do not crowd the pullets in the house or on the roosts. Each pullet needs at least four square feet of floor space in addition to a run of a yard.

MANAGEMENT OF MALE BIRDS

The management principles and practices involved in raising the pullets also apply generally to the male stock. The cockerels develop sexually earlier than the pullets and, unless they are separated, will worry the pullets to a degree that will seriously interfere with their development.

Care of Breeding Males. All pedigree cockerels and those that are strong, healthy, and free from defects should be separated, and reared separately for breeding purposes according to the management practices recommended for rearing pullets.

Sexing Day-old Chicks. In foreign countries where poultry is a well-developed industry, sexing of day-old chicks is done by engaging experts in the line who can distinguish the male chicks from the females by examining certain delicate structures in the cloaca. In the male chick there is a small rudimentary organ, which is missing in the female, but in many cases the differences are so minute that only a skilled sexing expert can recognise and separate the sexes. Lately, chick sexing instruments have been evolved which enable sex distinction to be made for the day-old chicks. Sexing of day-old chicks is also possible by what is called 'sex-linkage' or mating together certain breeds of poultry. This has already been dealt with in the chapter on Breeding.

Upgrading *Desi* Stock. It would be a sheer waste of excellent breeding material if all the surplus cockerels have to be disposed of for the table, as may be necessary if poultry were a well-developed industry in the country. At present a more useful purpose will be served by utilising them for upgrading the indigenous (*desi*) birds. Combined with the elimination of *desi* cockerels, large-scale distribution of improved cockerels will contribute materially to the improvement of the laying qualities of the *desi* birds. Any scheme envisaging systematic work in this direction would prove highly useful. It is possible that because of his ignorance and general poverty, the average villager may not be able to take advantage of these surplus cockerels by paying for them. For this reason it is advisable to distribute the cockerels at a very nominal rate if not altogether free, any difference in the cost of production and the rate at which they are required to be distributed for upgrading work being subsidised by the Government.

Exchange of Cockerels. It is possible that unless the improved cockerels are given away free of cost, the villagers may not generally agree to have them. But there can be little hesitation on their part in exchanging their indigenous cockerels with improved ones, either on bird-for-bird or weight-for-weight basis. Such an arrangement should be encouraged. The *desi* cockerels got in exchange for the improved birds can be disposed of for table purposes by auctioning them locally without having to incur any expenditure for their upkeep or transport.

It is needless to stress here that for any upgrading programme to be successful all the local cockerels should be eliminated, a sufficient number of cockerels in relation to the layers in the villages should be supplied, and feeding of the birds should be improved. As far as possible only one breed of improved cockerels suited to local conditions should be distributed in each area.

The above arrangement has been working successfully in a few of the States where it has contributed much to the improvement of poultry in the rural areas. A more intensive drive in this direction in all the States would provide a quick means of improving poultry production on a large scale.

Capons. Another way of disposing of the surplus males, not required either for breeding or for upgrading purposes, is by converting them into capons first and then selling them for table. A capon bears the same relation to a rooster as a bullock does to a bull. A capon loses its masculine appearance, becomes sluggish and gains weight rapidly. The growth of the comb and wattles is arrested; and unlike the rooster the capon does not crow. Its flesh remains palatable and savoury even when it grows up. The 'caponizing' operation has been dealt with under the chapter on Marketing.

In Western countries capons are preferred to ordinary males for the table, and fetch better price. In this country, however, there is yet no proper appreciation of the superior quality of the meat of a capon.

MANAGEMENT OF LAYERS

The general management practices already mentioned above under several heads apply also to the management of the layers. However, the following additional hints would be found useful.

Laying Houses. Just before the pullets start laying they should be transferred to laying-houses and put on the laying-mash. Flocks of laying birds should be as even as possible in size, and it is better to have in each laying flock birds of the same age group. Pullets and older birds should not be mixed as that would mean considerable risk to the new birds from worms, lice, ticks, etc.

Size of Laying Flock. For purposes of management small flocks are preferable to large ones. For breeding pens, especially for pedigree breeding, more than ten birds in a pen are not recommended. For flock matings, up to 50 hens can be kept in a pen. If it is merely table egg production, as many as 200-250 layers can be maintained in colony houses.

Egg Production. The main function of the layers is to produce eggs. Generally, a fall in egg production is primarily caused by low feed consumption. Unfavourable environment and management are contributory factors. The principal causes of low egg production, and the management practices which would help to improve production are discussed below.

Violent Changes in Weather: Inclemencies of weather, such as very high temperature during the summer months, very low temperature of the hilly regions in winter, and the incessant rains during the monsoon period in coastal areas, are responsible for lowering egg production because under these conditions the birds are generally not able to eat all the feed that they need. These can be remedied to a large extent by providing comfortable housing conditions. This has already been dealt with in the chapter on Housing.

Changes in Ration: Unbalanced and unpalatable ration should be avoided. Unbalanced food will not provide all the essential nutrients that a layer would need to produce the maximum number of eggs, while an unpalatable ration will lead to insufficient food being consumed by the bird and, consequently to low production.

Low Protein Ration: A well balanced laying mash should contain, beside other things, 15 per cent protein, in order that the egg yield does not suffer. Ration with low protein content affects egg production adversely.

Insufficient Feed: It is obvious that when layers do not get all the feed that they need for laying, they cannot give the best results. It is a principle of good management to let the layers eat as much of the laying-mash as they can by keeping the feed hoppers full all the time. A layer needs from 4 to 6 ounces of feed daily.

Lack of Feeder Space: Adequate feeder space should be provided in the laying houses or pens so that each layer has at least 3 inches of hopper space.

Inadequate or Irregular Water Supply: Eggs contain 66 per cent of water. For their production as well as for other physiological functions, the hens, therefore, need large quantities of water.

Poor Ventilation: Poor ventilation makes the house uncomfortable. Care should, therefore, be taken, to provide proper ventilation in the laying houses.

Diseases and Parasites: Infectious and other diseases and parasitic infestations (external and internal) are deterrants to egg production. Preventive and control measures as suggested in the chapter on Diseases and Their Control should be followed.

Shifting of Birds: Pullets should be transferred to the laying house at least 3 to 4 weeks before they are expected to commence laying. This will give them enough time to get used to new surroundings. The layers are very sensitive to any changes in their environments. Such changes have an adverse effect on their laying capacity. When once they have settled down to certain surroundings and started laying, they should not be disturbed unless shifting is absolutely necessary.

Rough Handling of Birds: The birds are extremely timid and are easily frightened by any attempt to chase and catch them. The result of any fright is low feeding followed by poor egg yield. The bird required to be caught for examination, culling or treatment should preferably be lifted when the flock is roosting at night, or should be caught by using a catching crate described in the chapter on Culling.

Change of Caretakers: Poultry in general, and layers in particular are sensitive to a change of caretaker. A new caretaker who is a stranger to them is looked upon as an intruder, with the result that a noticeable fall in the consumption of feed and corresponding loss in production occurs.

MANAGEMENT OF BREEDING STOCK

The importance of management factors in relation to a successful breeding plan has been dealt with in a previous chapter. There are other considerations that apply specially to the management of breeding flocks, and these are discussed below:

Ratio of Males to Females. Too few or too many males in relation to hens in the flock may cause fall in production. The approximate ratio for best results under average conditions are Mediterranean breeds, 1 to 15 or more up to a limit of 25; American and English breeds, 1 to 10 or 15; and Asiatic breeds 1 to 10.

Care of Breeding Males. When used for breeding the male bird is admittedly 'half the flock' and should, therefore, receive careful attention. Particular care is necessary to ensure that he receives sufficient food, for many males are so absorbingly attentive to the hens that they do not eat enough even to maintain themselves in a vigorous condition. It is well to feed the male apart from the hens.

Attention should be paid to the claws, and spurs to see that they are blunt on sides and points in order to avoid damage to the backs of hens. The feet should be examined to ensure that there is no bumble foot or any other trouble that would prevent satisfactory service. The males should be kept free from lice, mites, fleas and ticks by frequent application of sodium fluoride and other insecticides, as these external parasites rapidly spread throughout the entire flock from an infested male.

Breeding Age. When a good male has been discovered through progeny testing, he should be used as long as he gives reasonably good fertility. Otherwise preference should be given to young males. The first year is usually the best for any male, from the point of view of fertility. Many are of little value after the second year.

As regards the females, the available evidence supports the view that yearling hens give somewhat better results than the pullets in respect of both hatchability and the size of chicks when hatched. Genetically, a pullet should give the same results as she will give later as a hen, but the fact that her eggs are generally smaller and, therefore, yield smaller chicks, as also the fact that she should usually lay more heavily during the winter of her pullet year, are a sufficient justification for preferring hens to pullets for breeding. A very important advantage in the case of hens is that their performance is already known, and this is of great value in selecting suitable birds for a breeding plan.

Fertility of Eggs. It is possible for a hen to lay a fertile egg within 24 hours after mating, but a longer time must elapse before the percentage of fertile eggs from a flock will be sufficiently high to warrant saving them for hatching purposes. To get a high fertility rate it is advisable to save eggs for hatching after 7 to 10 days of mating, depending on the breeds involved.

Methods of Mating. Several methods of mating are practised for producing fertile eggs. These are: (i) pen mating; (ii) flock mating; (iii) stud mating; (iv) alternating males; and (v) artificial insemination. These have already been discussed in the chapter on Breeding.

OTHER MANAGEMENT PROBLEMS

In addition to the problems already discussed, there are several others which the poultry keeper has to face. The more important of these are: (i) management of the broody hens, (ii) seasonal distribution of egg production, (iii) laying cages or batteries, and (iv) disposal of poultry manure.

Management of Broody Hens. When hens not required for setting

become broody, they should be removed from the flock and induced to lay again as soon as possible. This can be accomplished by confining them in a coop with a wire-mesh bottom, which offers no opportunity for them to rest.

Distribution of Egg Production. A great majority of the layers follow a natural tendency to lay well during certain periods of the year like the spring and not so well at other times, with varying periods of non-production during the moulting season. It is obviously desirable to maintain egg production at a steady high level throughout the year. While this has generally to be secured through better breeding, it is possible to influence the distribution of egg production over a period of time with the help of a sound management policy.

Forcing the Moults. One of the most obvious methods of influencing the distribution of egg production is to bring about an early moult so that the hens may get back in laying condition before the normal seasonal fall in egg production occurs in the fall months. Theoretically, the plan sounds very encouraging, but it fails in actual practice, because it is easy enough to bring about the moult at any pre-determined period, but not so easy to cause the hens to lay at a high rate at the right time. Nevertheless, this method seems to find favour with more and more poultry-men in the West and deserves study.

The method consists in restricting the diet of the flock, for sometime between June and July, to grain alone with no mash or protein supplement. After a rest period of about eight weeks the birds are put back on full feed, preferably under artificial light during the nights to encourage egg laying. Though the experience of poultry-men with this method has not been uniformly encouraging, the idea seems to merit experimentation. The method, however, should not be understood as being one that would turn the inherently poor producers into profitable layers.

Laying Cages or Batteries. The practice of keeping laying hens in individual cages or batteries is becoming increasingly popular in the West. Laying batteries not only make it possible to keep fowls in buildings which are not suitable for laying hens, but also reduce space requirements as well as mortality. The use of laying cages or batteries is also solution of management problems like cannibalism, damp litter, trapnesting, etc. The disadvantages are: (i) higher percentage of cracked eggs, (ii) necessity for frequent removal and cleaning of droppings, (iii) need for special attention to rations suitable for caged or battery layers, and (iv) difficulties of ensuring prompt replacement of birds which die, cease laying or are culled.

Disposal of Poultry Manure. Poultry manure is a valuable by-product of poultry farming. Many poultry-keepers would find it profitable to give more attention to the utilisation of this product. Since poultry manure contains not only the faeces but also the excretions from the kidneys, it is much richer in nitrogen than that of other domestic animals. Poultry manure has, therefore, considerable value as a fertilizer. But in order to retain its maximum fertilizing value it has to be properly conserved. Much of its value is lost on account of improper storage.

The approximate quantity of fresh manure produced by poultry is as follows: yield from 100 laying birds per annum—10 tons (280 md.); and that from 100 chickens, from hatching time to 6 months' age—25 cwt. (35 md.).

A ton (28 md.) of fresh poultry manure unmixed with litter contains about 20 pounds of nitrogen, 16 pounds of readily available phosphoric acid, and 8 pounds of potash. Poultry manure is 24 times as rich in nitrogen as farmyard manure, and four times richer in phosphoric acid, though slightly lower in potash content.

To conserve the fertilizing value of stored poultry manure, it should be mixed with sawdust or other fine textured and equally absorbent litter. This is best done by scattering the drying material on the dropping-boards each day after cleaning. If in addition superphosphate is added daily at the rate of 3 pounds to the manure produced by a flock of 100 hens, the fertilizing value of the manure would be reinforced and the unpleasant odours would be kept down. Poultry manure is an ideal manure for lawns and orchards.

13

MARKETING

THE total poultry population in India according to the 1961 census is about 116 millions. Out of this, about 40 million birds are hens with an average laying capacity of about 53 eggs per bird per year. Even at the present low rate of production, the number of eggs produced annually comes to about 1,900 millions with a market value of over fifteen crore of rupees. The value of table poultry has not been estimated, but it cannot be less than that of the eggs. The total number of chickens and eggs produced throughout the world* are 115,665 and 763,731,000 millions, respectively. Roughly, therefore, we have in this country more than one-tenth of the world's chicken population, though of low productivity. Table 23 gives the poultry population and annual production of eggs in ten important countries.

Table 23. NUMBER OF CHICKENS AND EGGS IN SPECIFIED COUNTRIES (1953)

Country	Chickens (Millions)	Eggs (Millions)	Remarks
Canada	38.5	4,200	
U.S.A.	429.7	61,704	
Denmark	24.7	2,155	
France	70.0	8,000	For 1952
West Germany	51.3	5,500	
U.K.	88.1	6,200	
China	194.6	—	For 1950
Japan	36.6	5,140	
India	97.0	1,700	
Pakistan	59.0	—	For 1952

In spite of the large poultry population in India the output of eggs is low on account of the small average productivity of the individual birds. The *desi* (indigenous) hens are estimated to lay on an average 53 eggs per bird annually as against the world average of 120 eggs per bird. 'Improved' hens bred from imported stock lay on an average 103 eggs a year, but the number of such birds is small and does not exceed 1.25 per cent of the total laying birds.

*Poultry Science Journal, Vol. 10, 1954, pp. 146-49.

Poultry Husbandry in India. Poultry keeping in India, is as it should be, largely concentrated in rural areas where the average number of birds kept by a villager is about six, and the keeping conditions are anything but suitable. On account of high mortality from diseases, a large percentage of the laying stock has to be replaced every year. Taking this into consideration and allowing for the fact that producers far removed from the market retain most of their eggs for local consumption, it is estimated that nearly 60 per cent of the eggs find their way into the market to meet the needs of the consumers in urban areas. The total value of these eggs is over 9 crore rupees even under the present disorganised conditions of production.

Eggs are used in three principal ways, namely for household use, for confectionary, and for other (industrial) purposes. Over 95 per cent of the eggs consumed by the urban population in this country are used for table and cooking purposes in the households, and most of the remaining 5 per cent are used in confectionary. The number used for other purposes, e.g., glazing, book binding, preparation of medicines, tanning, etc., is comparatively very small at present.

From the foregoing account it is apparent that the urban demand is of primary importance from a marketing point of view, and that the bulk of the eggs which find their way into the market is for human consumption.

Marketing Problems. The consumer's interest in eggs relates mainly to their quality. The ultimate objective of any system of marketing eggs is, therefore, to put them in the hands of the consumers with their original quality unimpaired.

It is estimated that more than fifty lakhs of rupees are lost in the egg trade every year on account of defective collection and handling. According to the information* collected by the Directorate of Marketing, Ministry of Food and Agriculture, Government of India, losses due to faulty collection are believed to be of the order of Rs. 14 lakhs annually. This loss is mainly due to the present unsatisfactory methods of keeping poultry and could be greatly reduced by the provision of better housing and nesting facilities. Breakages in the course of collection, transport and distribution are also high and amount to about Rs. 15 lakhs per annum. Unsatisfactory containers and packing are largely to be blamed. Use of improved containers and suitable packing materials would reduce the losses on this account considerably.

Rapid deterioration in the quality of eggs or 'staling' during transit and marketing process explains losses, estimated at Rs. 28 lakhs a year. The various factors responsible for deterioration are: (1) hot weather conditions; (2) storage in warm dry places; (3) dirty eggs; (4) fertile eggs; (5) ungraded eggs; and (6) defective packing and handling.

Eggs deteriorate quickly if they are not properly looked after. Fertile eggs deteriorate more rapidly than infertile eggs, especially in the high temperature of summer (Fig. 137). This is because of the development of the germ or embryo which takes place in such eggs under warm conditions, and the length of period during which the eggs remain unconsumed determines the extent of deterioration.

* Report on the Marketing of Eggs and Poultry.

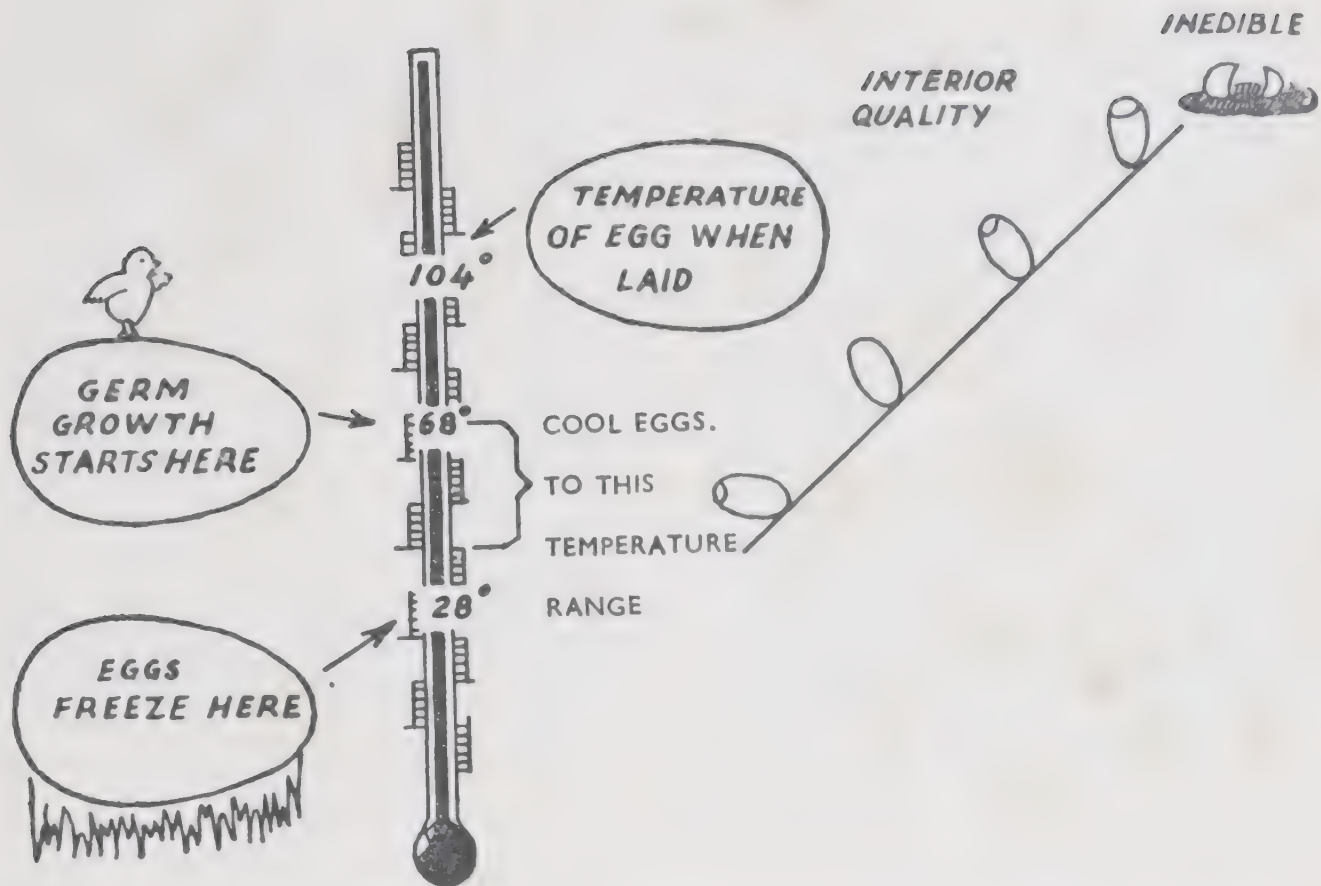


FIG. 137. INFLUENCE OF TEMPERATURE ON THE INTERIOR QUALITY OF EGGS (After A. E. Botsford, Cornell University, Department of Agriculture, U.S.A.)

Determining Quality of Eggs. The quality of the egg-contents can be generally determined by candling without breaking the egg. Candling is done by examining each egg separately in a dark room by means of an egg candler (Figs. 138, 139). This is a simple device consisting of a wooden or metal box with an oval aperture of approximately the shape of the egg on one of its sides. The box contains a source of light preferably a 50 watt lamp. Eggs to be examined are placed one by one on the aperture and the contents observed through the transmitted light.

A normal fresh-laid egg when candled presents a dim shadow of the yolk with no air-space at its broad end. Any abnormalities can be recognised, and the quality assessed. Candling market eggs is necessary not only to eliminate bad eggs but also to grade eggs according to quality.

Defective Shells. Carelessly handled eggs spoil to a much greater extent than those handled carefully. Faint cracks due to bad handling are easily seen by candling although they cannot be observed ordinarily. Such eggs are called *blind cheeks*. Eggs from which the contents leak are called *leakers* and no candling is necessary to detect them. All cracked eggs should be eliminated.

Air-cells. The depth of the air-cell determines the degree of staleness. In a normal egg, kept in a cool place for about one day the air-cell is about $\frac{1}{8}$ th of an inch in depth. The longer an egg is kept the larger is the air-cell. The size of the air-cell is an important factor in the candling of market eggs, because it

is an indication not only of the conditions under which eggs have been kept, but to some extent also of the age of eggs (Plate 5).

Blood Clots. Blood clots are at times seen on the surface of the yolk when eggs are candled. The clot is probably the result of a rupture of a blood vessel in the ovary or oviduct. Occasionally, the thick and thin white may have a reddish cast because of the presence of blood. Such eggs should be rejected.

Blood Rings and Germ Development. The germ of a fertile egg begins to develop at about 69° F. A blood ring, which appears at the surface of the yolk when an egg is candled, is due to the development of the embryo for a few days before it dies, resulting in the blood of the dead embryo collecting in a small ring. In fertile eggs collected at temperatures above 69° F., as is usually the case during the summer months, the germ usually continues to develop. This is a common experience in this country during the hot months, especially with eggs produced in the villages, where because of the constant association of the male birds with the layers, the eggs are invariably fertile. It is imperative, therefore, that eggs for the market should be kept at a temperature lower than 68° F., a temperature of about 55° F. being most desirable to preserve their quality.

Deterioration of Yolk and White. In a fresh egg the yolk should be seen well in the centre, a position which it retains even if it is boiled. In a stale egg the yolk is invariably out of the centre. The contents of a fresh laid or good quality egg when opened and gently poured into a flat dish occupy a small area with the thick white sticking round the yolk with very little of thin white, the yolk itself standing well up in the centre of the white (Plate 6a). A poor quality egg when treated similarly covers a wider area (Plate 6a, b, c). In stale eggs there is little or no thick white surrounding the yolk; instead the thin white spreads out thinly and surrounds the yolk which is itself enlarged and flattened.

The temperature of an egg when it is laid is about 104° F. In summer the thick white tends to break down a few hours after the egg is laid, unless it is removed from the nest promptly. Eggs allowed to remain in nests under very severe summer conditions such as obtaining in the North, without prompt cooling, deteriorate quickly. The higher the temperature and the drier the air of the room in which eggs are kept, the more rapid the deterioration. Excessive heating of eggs whether from exposure to the sun or for being in storage for a long time in a warm room, results in a complete breakdown of the thick white, giving the entire white a watery appearance. Such eggs, in advanced stage of deterioration, are called 'watery whites'. The yolks in these appear dark in colour when candled, and twist freely in the white of the eggs and are called 'light floats' or 'heavy floats'.

Bacterial Contamination. The contents of normal fresh-laid eggs are comparatively free from bacteria as the shell, with its natural bloom, normally prevents bacterial contamination. Faecal matter and other dirt on the shell may give rise to bacterial contamination, especially if eggs are held in a warm and moist atmosphere. A cracked shell may permit bacteria to enter the egg and contaminate its contents. If bacterial decomposition continues, rot of one kind or other follows. Such contaminated eggs are unfit for consumption.



AA Quality : Air Cell— $\frac{1}{8}$ inch or less in Depth



A Quality : Air Cell— $\frac{2}{8}$ inch or less in Depth



B Quality : Air Cell— $\frac{3}{8}$ inch or less in Depth



C Quality : Air Cell—over $\frac{3}{8}$ inch in Depth

Egg Cuddled at Different Intervals for Testing Quality.

PLATE 6



a. Much thick white and small thin white



b. Considerable thick white and medium thin white



c. Small thick white and much thin white



d. No thick white and large thin white

Contents of Fertile Egg at Different Intervals

Absorption of Other Odours. The porous nature of the egg shell and shell membrane makes it possible for bad odours and flavours to penetrate the egg and taint its contents. Eggs should not be allowed to come in contact with products having strong flavours.

Production of Quality Eggs. An egg once laid cannot be improved in quality. It is, therefore, necessary for flock owners to take such measures as would ensure production of superior quality eggs. By resorting to sound breeding, feeding and management practices, it is possible to produce high grade eggs. These when followed by sound handling, packing and transport arrangements help to preserve, as far as possible, the desirable qualities and reduce a great deal of wastage, which normally occurs, if no such measures are taken.

Handling Eggs. When the birds are kept under farming conditions, the eggs should be gathered at least three times daily in winter, and as frequently as possible in summer. This will prevent the eggs from getting dirty, broken in the nest or heated.

Wire baskets, perforated pails, well-ventilated wooden boxes or baskets make the best containers for the eggs. Eggs cool down to room temperature nearly twice as fast in such containers as in ordinary metal pails or solid wooden containers. Immediately after the eggs are gathered they should be taken to a cool room. A good egg-carrier should be firm enough on the sides and bottom, and when filled with eggs and lifted by the handle should not bend to the extent of crushing the eggs.

Dirty Eggs. Dirty eggs should not be marketed at all. Eggs, like all other food products, are sold largely on their appearance. They should, therefore, be spotlessly clean. When eggs are slightly dirty, the spots can be removed by wiping them with a clean damp cloth. Washing the eggs removes the protective 'bloom' on the egg-shell leading to excessive evaporation of their moisture content. To remove thick spots and patches of dirt, steel wool, fine sandpaper, or emery cloth should be used in preference to washing with water. In a large production or collecting centre the use of mechanical cleaners is both time-saving and efficient.

Clean litter and clean nests are essential for the production of clean eggs and prevention of dirt. A nest should be provided for every 5 or 6 hens. It is particularly important to keep the litter dry.

Preserving Egg Quality. Preservation of the quality of eggs approximating as near as possible to that of fresh-laid ones is of great importance in marketing. The problem is, however, beset with great practical difficulties, especially under conditions of village production. The following measures will be useful in preserving eggs.

Production of Infertile Eggs. Preservation of egg quality starts at the point of production. Production of infertile eggs instead of fertile ones helps in preserving egg quality considerably. This can be done by separating the cocks from the hens except during the breeding seasons. Many people are under the erroneous impression that the presence of a male bird is necessary for the hens to lay eggs. Hens lay without the presence of the cock bird and such eggs are

infertile. Wherever it is possible to keep the sexes separate, at any rate with the onset of summer and till the fair weather sets in, this should be done. This is, however, not always practicable under the existing conditions of poultry rearing in villages. Where it is not possible to keep the male birds separated even for a short duration, defertilization of eggs has to be recommended.

Defertilization. Defertilization consists in keeping the eggs in hot water maintained at a temperature of 135° F. to 145° F. for about 15 minutes. This temperature is just enough to destroy the germ leaving the contents of the eggs intact. A defertilized egg is as good as infertile egg inasmuch as the embryo cannot develop in it. Defertilized eggs keep better and longer.

An ordinary long, preferably wide mouthed, tin or aluminium vessel filled two-thirds with tap water is heated over fire till the water reaches 135° F. which is judged by the feeling of discomfort when one's finger is dipped in it for more than ten seconds. If the temperature could be actually measured with a thermometer it would be better. At this stage the vessel is covered with a lid and removed from the fire. Eggs to be defertilized are put in an open basket, preferably made of wire, and then lowered into the hot water so as to immerse them completely. They are allowed to remain in it for 15 minutes after which they are removed and stored in some cool place. This method can be easily adopted by village co-operatives. A four-gallon empty kerosene tin with one of its ends cut open will serve the purpose of a water-bath, and suffice for handling about 500 eggs daily. One or two wire baskets and a thermometer are all the additional equipment that would be needed by these co-operatives. The small cost involved will be more than offset by the margin of profits, as defertilized eggs are expected to fetch better prices to the producers.

Where well-organised marketing organisations or centres handling a large number of eggs exist, it is very desirable to install a somewhat more elaborate defertilization plant so that the large number of eggs needing treatment may be dealt with efficiently and economically. Such defertilization centres can be installed at little cost, and consist merely of a few water tanks with mechanical stirrers, electrical heating arrangement (wherever possible) and some wire baskets for dipping eggs. If an egg cooler can be attached to such a unit, it would complete the equipment needed for the preservation of eggs.

Cooling Eggs. It has already been pointed out that a temperature exceeding 68° F. is favourable for the development of the embryo and consequently makes for rapid deterioration of the egg quality. A temperature below 68° F. will help prolong the freshness of the eggs. In winter months no special cooling arrangement is necessary in places where the temperature is low enough to prevent the development of the embryo. The ideal is, of course, refrigerated coolers. However, in the absence of any well-organised egg-marketing societies, refrigeration facilities cannot be expected to reach the individual rural producer. It is possible to resort to some simpler home made devices which might help keep the temperature as low as possible. A few such inexpensive contrivances which can be adopted under village conditions are mentioned below.

Cool Room: Eggs should be kept in a room made as cool as possible by providing all the outlets with *khus khus tattis* kept constantly moist, and by sprinkling water on the floor as often as possible. An electric ceiling fan will add to the coolness of the room.

Underground Cellar: In the absence of suitable room an underground cellar or pit can be expected to provide sufficiently low temperature to keep the eggs cool.

Earthen Pot: A sufficiently large earthen pot to accommodate a week's production can be kept cool by keeping it partially buried in a sand heap on which water is sprinkled frequently. The bottom of the pot should have a layer of clean dry hay or straw inside so that eggs do not come in direct contact with the percolating dampness. The mouth of the pot should be kept covered with either a perforated lid or thin muslin to permit free passage of air and moisture (Fig. 141). The pot should be kept in a well ventilated and airy part of the dwelling. The simple device will help to bring down the temperature by at least 10°F.

Home-made Cooler: If a little extra expense could be afforded, an equally efficient but much cleaner home-made cooler can be installed in the producers' houses, as well as in the village co-operatives having egg-marketing as one of their activities. This consists of a simple wooden framework 3' square and 4' high, provided with two or more shelves, and open on all sides (Fig. 140). Moist gunny cloth is wrapped on all the four sides, with one end dipping in a water pan on the top of the frame. The temperature inside the frame remains sufficiently low and helps preservation of eggs.

Frozen Eggs. Freezing is one of the best ways of preserving eggs, if facilities are available. Separated yolks, and whites, or mixed whites and yolks, can be preserved through freezing which checks the growth of bacteria. Frozen eggs are dependable in quality and are particularly used for the preparation of such foods as ice-cream, mayonnaise, confectionary, etc.

Dried Eggs. A more convenient way of preserving eggs than even freezing is by drying the eggs. Dried eggs can be stored for many months even at a comparatively high temperature. Because of this, and owing to the fact that they do not need refrigeration, they are easy to be transported over long distances. China has built up a very lucrative export trade of dried eggs.

There are three ways of drying eggs: the belt, spray and pan methods, the processes being the same as those used in drying milk. The whole egg, or the yolks and whites separately, may be dried. The whole egg is of use for bakery products, the yolk for flours, and the albumen for confectionaries.

With present low egg production and unsatisfactory marketing facilities, preservation and storing of eggs by freezing and drying cannot be of immediate interest to us.

HOME PRESERVATION

Generally no special methods are practised for short-period storage or holding of eggs. The eggs are put in baskets and left in a cooler part of the house, a dark room being preferred.

Occasionally, specific indigenous materials such as green *neem* (*Melia azadirachta*) leaves (Hyderabad); green *shisham* (*Dalbergia sissoo*) leaves (Punjab and U.P.); mulberry leaves (Punjab and U.P.); rice husk or bran (Kerala); dry salt (Madras); moist sand (Bihar and Orissa); and dry charcoal powder or slaked lime (Madhya Pradesh), are used for the storage of eggs. These materials are placed with the eggs in boxes or simply heaped on the floor in a corner of a room. No doubt most of the materials are available free in the village, but as already stated, little is known about their efficiency as materials suitable for holding eggs. For instance, green *neem* leaves are said to exert a cooling effect on the eggs, but they are also credited with imparting a bitter odour. Rice husk is supposed to be useful, but even if slightly moist, it imparts a peculiar unpleasant odour to the eggs besides leaving unsightly patches on the shell.

The preserving of eggs when they are relatively plentiful and cheap for use in the off-season when they are scarce and more expensive, is good economy whether or not a flock of hens is kept. Eggs for preservation should be fresh, clean and either infertile or defertilized. Three methods which are cheap and efficient are explained below.

Oil Protected Eggs. The process of protecting eggs by dipping them in warm oil is a satisfactory method of making good eggs keep longer and better. The object of oil treatment is to seal the pores of the shell partially, thus preventing evaporation and loss of carbon dioxide. Oiling should be done as soon as possible after the eggs are laid and before they are marketed. The oil should be colourless, tasteless and odourless. Coconut oil has been used with success.

Water-glass Method. Of the various methods of preserving eggs for household purposes, the water-glass method is generally considered the best. The materials needed for preserving 15 dozen eggs are: one 8-gallon mud pot or earthen crock or jar, 3/4 quart of commercial water-glass (sodium silicate) and 9 quarts of boiled water.

Boiled water when it is cool is poured into the jar or earthen pot (which should be clean), the water-glass is added, and both thoroughly mixed with a wooden ladle. Eggs are carefully lowered into the solution taking care that all are completely immersed in it. The jar or pot is covered and kept in a cool place.

Lime-water Method. Lime water can be used equally satisfactorily in place of water-glass solution. It is prepared by mixing about 5 lb. of quick lime in 10 lb. of water and stirring the mixture well. The mixture is left to stand overnight, and the clear liquid on decanting can be used in the same way as water-glass solution. Evaporation is avoided by adding a little mineral oil on the top of the solution. The container should be placed in a cool place.

Eggs prepared either by water-glass or by lime-water method will keep in excellent condition for several months, provided fresh clean infertile eggs are used. They can be removed as needed, and can be used in any way except boiling which cracks the shell, unless small hole is first made in it with a pin. Eggs to be preserved in water-glass and lime-water should not be washed.



FIG. 138. HOME-MADE EGG CANDLER



FIG. 139. EGG CANDLER (IMPROVED TYPE)

FIG. 140. HOME-MADE EGG COOLER



FIG. 141. AN INEXPENSIVE METHOD OF KEEPING EGGS UNDER VILLAGE CONDITIONS

GRADING EGGS

Generally, large eggs command higher prices than smaller eggs; but apart from the size, the value of an egg depends on its qualities. The external appearance of the shell must be clean and free from stains. The eggs should have the normal shape and texture. The interior quality which can only be satisfactorily judged by 'candling' consists in the contents being free from blemish such as blood spots or rings. The yolk should be in central position, translucent, faintly outlined, and not moving very freely about the axis. The air-space at the broad end becomes larger as the egg gets older, so that in the case of fresh eggs it should be small.

Advantages of Grading. It is customary for wholesale distributors to buy eggs from the producers and dealers, especially in rural areas, at a flat rate regardless of the size of eggs. These eggs are sorted out by the distributors on the basis of quality, and sold at prices which vary according to the grades. A marketing survey undertaken on this aspect has revealed that sorting and grading by distributors at the consuming end can account for increased price returns of over 8 per cent. There is no reason why the profit on grading and sorting should not go to the producers rather than the distributors, and it has been actually shown that by grading and packing the eggs before despatch to the consuming centres, increased price returns of 15 to 20 per cent can be obtained. According to the egg marketing survey report this is accounted for by the fact that eggs which might deteriorate during transport can be sold locally as 'fresh', and that cracked and slightly stale eggs can be sold at a reasonable price locally, whereas they would be entirely unfit for sale if sent to distant markets. Apart from the enhanced price obtained for the graded eggs there is a saving in freight by retaining those in the producing area which are not fresh or are damaged.

Standard Grades. Systematic grading must, however, be done on the basis of standard grades (Fig. 145). First quality eggs should be known everywhere by the same name, and similarly second and third qualities should have distinctive descriptions familiar to all consumers. Rules have been made by the Government of India under the Agricultural Produce (Grading & Marketing) Act, 1937, prescribing the names—Special, Grade A, Grade B and Grade C for 'AGMARK' eggs.

Apart from introducing 'AGMARK' grading on Government farms and few of the egg marketing societies that exist, no substantial measures have been taken in this direction in rural areas. In order that poultry keeping may develop into a profitable cottage industry, a more efficient marketing organisation than the existing one is very necessary. Rural co-operatives are the appropriate agencies to undertake this responsibility, and proper grading of all the eggs handled by them is necessary in order to ensure maximum profits.

Agmark Standards. The various standards stipulated in the 'AGMARK' specifications under the Agricultural Produce Act, 1937 and the method of grading the 'AGMARK' eggs are reproduced below from the report 'Agricultural Marketing in India Relating to Marketing of Eggs in India and Burma', (Marketing

Series No. 9, 1938). For the sake of convenience the 'AGMARK' specifications are also given below:

GRADE DESIGNATION AND DEFINITION OF QUALITY OF EGGS (HEN AND DUCK) PRODUCED
IN INDIA

Grade Designations	Definition of Quality			
	Hen Eggs		Duck Eggs	
	* Minimum wt. (oz.)	State or Condition	Minimum wt. (oz.)	State or Condition
Special	1-7/8	The eggs must not have been preserved by any process and must be free from taint, the shell must be clean, free from stain, sound, of normal shape. The contents must be free from blemish, the yolk central and translucent or faintly but not clearly outlined and freely mobile; the white must be translucent and clear and the air-space must not exceed three-eighths of an inch in depth.	2½	The eggs must not have been preserved by any process, the shell must be clean, free from stain and sound, the yolk central, visible but not dense, and freely mobile. The white must be translucent, firm and not watery.
A	1-3/4		2½	
B	1-1/2		2	
C	1-1/4		1¾	

*To allow for accidental errors in grading a tolerance of 1 drachm in the weight of any egg may be permitted.

*Explanation of Quality**

In column 3 above are given the specifications for interior quality of the 'AGMARK' eggs. It would be noticed that they are identical for large or small eggs, but are slightly different for hen and duck eggs.

(i) *The Shell—Clean*: A clean shell is one which is free from any extraneous matter, strains or discoloration. *Sound*: A sound shell is one that is free from visible or blind cracks. *Normal texture and shape*: A normal shell is one which approximates the usual shape and which is of good even texture.

(ii) *The Yolk—Central*: A yolk that occupies the centre of egg without much movement from that position when the egg is twirled. *Not clearly outlined*: A yolk, the outline of which is not clearly discernible when viewed before the candle. *Freely mobile*: A freely mobile yolk is one which shows a wide movement, or swings away from the centre of the egg, when it is twirled before the candle, and comes sufficiently close to the shell to cast a decidedly dark shadow.

(iii) *The White—Translucent and Clear*: A white which is free from discolourations which before the candle appear as dark bodies.

(iv) *The Air-space—Not More Than Three-eighths of an Inch in Depth*: When in its natural position the depth of the air-cell is the distance from the broad end

* Some of the terms used in here are borrowed from the Handbook of Official United States Standards for individual eggs.

the egg to the lower edge of the air-cell, where it touches the shell, which must not exceed three-eighths of an inch.

Explanation of Quality of 'AGMARK' Duck Eggs

(i) *The yolk—Visible But Not Dense:* When a freely mobile yolk closely approaches the shell, when twirled before the candle, it should not appear as a dense or dark shadow.

(ii) *The White—Firm:* A firm white is one which is sufficiently thick or viscous to permit but little movement of the yolk from the centre of the egg. *Not watery:* The white which is not thin, or lacks viscosity and shows a dark shadow of the yolk, as the egg is twirled before the candle.

GENERAL METHOD OF GRADING AGMARK EGGS

It is of utmost importance to see that no time is wasted during grading. It has been noticed that the work at a grading station can be divided into six convenient stages as follows:

First Stage—Sorting Cracked Eggs and Cleaning Other Eggs: Since village eggs include dirty and damaged ones which cannot be graded, they are sorted out at the very start. This is done by hand and takes but a few minutes. The Rules under the Act require that the egg-shell must be 'clean', free from stain, sound, and of normal texture and shape. The cleaning may be done with a damp piece of felt, but care must be taken to avoid the use of excessive water. It is observed that with a little practice a helper can generally clean about 700 to 1,000 eggs per hour.

The use of egg cleaning machines may also be tried as an efficient machine operated by hand can clean and dry about 1,500 eggs per hour. The machine cleaning is, however, recommended for merchants handling over 5,000 eggs per day.

Second Stage—Candling: Candling is done with the help of a strong light. Since electricity is still not available at most of the places, an ordinary Petromax lamp covered with a metal hood is used for candling. The lamp is placed in the corner of the room, which is darkened with a black curtain. The egg is held with the large end upward, between the thumb and the first two fingers, at a distance of about a foot from the eye, and as near as possible to the aperture of the lamp. It is given a quick twirl so that the contents may rotate. A reverse twirl may also be given. According to the Rules under the Act, 'the contents of the egg must be free from blemish, the yolk central, and freely mobile; the white must be translucent and clear and the air-space must not exceed three-eighths of an inch in depth'. When a normal fresh egg* is candled the entire contents appear pinkish yellow, but by looking closely the air-space at the larger end and the diffused shadow of the yolk near the centre are seen.

**Signs of a bad egg*—If the yolk moves quickly and shows blood, meat or black spots, or is discoloured, patchy or sticking to the sides, and if the white is indistinct, discoloured or cloudy, or there is a large air-space the egg is considered as stale.

It has been found that when the grade specifications are clearly understood, a helper can candle 600 to 900 eggs per hour, if not more.

Third Stage—Grading: After the sound uncracked eggs are cleaned and examined for their freshness, they are sorted into different grades according to the Rules. Grading is done with the help of machines* of various sizes. For grading 2,000 to 3,000 eggs per hour the machine costs Rs. 400 to Rs. 1,000. These machines are generally suitable for merchants handling over 10,000 eggs per day. For those handling up to 3,000 eggs per day, a small and simple machine is available for Rs. 20.

Fourth Stage—Marking or Stamping Graded Eggs: The rules require that “the mark on each egg shall consist of the word ‘AGMARK’ together with the grade designations (Special, A, B, and C) placed centrally in a circle of not less than $\frac{1}{2}$ inch diameter and further, “the grade designation mark shall be marked legibly on each egg in indelible ink on the shell by means of a rubber stamp.” The eggs are laid flat on a padded tray and marked gently with the stamp.

Fifth and Sixth Stages—Packing and Affixing AGMARK Labels: The rules regarding packing are: ‘The contents shall be clean and suitable for the purpose. Packing material if used shall be clean, dry and sweet, free from any taint liable to impart an objectionable odour to the eggs. Hen and duck eggs shall be packed separately as far as possible. If more than one grade are packed in one container, a layer of clean paper or clean straw shall be placed between the different grades’.

After the above has been complied with, the grade designation label bearing the ‘AGMARK’ is attached by means of a lead seal to each package of eggs. The labels have different colours for different grades. They have written on them (1) grade designation (Special, A, B, and C), (2) number of eggs, (3) their weight, (4) the name of the packing station, and (5) the date of despatch.

Packing. Packing the eggs properly is one of the requisites of good marketing and better income. This aspect is sadly neglected at present, and packing is generally done in baskets, which as a rule are much too fragile and, therefore, insecure for the contents. It is customary to put the eggs in the baskets without any protective packing materials. The baskets also lack in firmness; and it is, therefore, impossible to lift them without breaking some of the eggs. This is particularly applicable to the type of baskets used commonly in the North, where under ordinary circumstances, breakages ranging from 10 to 30 per cent during transshipment have been recorded. It is estimated that the damage resulting from defective containers amounts to about Rs. 15 lakhs per annum.

Much, therefore, has to be done in the way of popularising the use of firm containers and good packing material. The type of baskets used in the South seems to serve the need better. They are more rigid and have bamboo lids.

*Machine grading is done on the basis of weight as indicated in the Rules, but since weight and size are fairly closely related, it is possible to grade eggs by hand (without any mechanical help) on the basis of size, as determined by individual judgement. In such cases, the weight should be checked occasionally by a small egg-weighing scale (costing about Rs. 3.)

MARKETING

Use of a small amount of paddy straw for packing eggs in such baskets is responsible for the low rate of breakages in the South. Earthen pots and jars are also occasionally used particularly for packing pickled eggs. Boxes are used only in a few places, the limiting factor being the initial cost involved. Any arrangement under which the boxes may be returned for repacking, apart from entailing additional cost on the transport of empties, also faces the risk that the box may never be returned. It has been shown that by improving the container and packing the eggs properly, a net gain of 5 per cent can be obtained in price returns through a reduction in breakages. This gain taken in conjunction with the anticipated gain of 20 per cent in income obtained for graded eggs, indicates that the establishment of grading-cum-packing centres would be highly desirable.

MARKETING POULTRY BIRDS

The table-poultry trade is not a specialised job in India as in the Western countries. Birds in the villages are generally sold when there is a threat of an outbreak of a poultry-disease, either within the villages themselves or in their immediate neighbourhood. When birds from infected villages are purchased and taken to disease-free areas, the healthy birds in the latter get infected. The poultry markets, therefore, contribute largely to the spread of the diseases and the consequent heavy losses.

Sometimes birds considered surplus in a flock are disposed of, and occasionally a few birds are sold in the local weekly markets to defray household expenses. The average price which they fetch varies widely according to the season and locality, but usually it is lower than what it would cost to rear them under farming conditions. Considering that practically nothing is spent by the villagers in rearing them, whatever the price realised is to be regarded as a net profit.

Broiler Production. Specialised poultry keepers who may attempt to put pure-bred table chickens or broilers in the market cannot, therefore, compete with the low priced village poultry which finds its way to the consumers through the urban markets or hawkers. To an average consumer in India, the superior size and weight of an improved breed of chicken, such as a broiler, is of little interest. On the other hand he prefers a smaller bird like the *desi* chicken as it is not only cheaper but is also just enough for his family's one meal. In the absence of such facilities as refrigerators or cold storage, portions of cooked or uncooked chicken cannot be held over for a subsequent meal, and any extra weight of the chicken in excess of the one-meal requirements is of no consequence to him. Improved poultry for table-purposes or broiler production, which is a profitable venture in the West, does not, therefore, hold out much scope at present for a profitable farming enterprise in this country.

Disposal of Surplus Birds. Disposal of surplus stocks reared under village conditions presents no serious difficulties, but the prices realised vary widely, being subject to much exploitation by the middlemen or hawkers. At present only live

birds are disposed of, and consumers generally do not like the idea of using dressed and preserved carcasses. There is much scope for village co-operatives in the field of marketing live birds to the consuming areas so as to ensure better returns to the rural producers. The price scale should be determined on the basis of live weight instead of mere numbers.

Disposal of unwanted stock on a commercial farm presents, on the other hand, considerable difficulties for reasons already mentioned. Such a stock consists of culled birds, surplus birds and cockerels. It is profitable to dispose of culled birds for table for whatever price they may fetch at an open auction sale, as the maintenance cost of the otherwise unprofitable birds which constitute the culls is a serious drain on the farm income. Surplus birds, otherwise suitable for breeding, should be sold only at a good profit.

Disposal of Surplus Cockerels. As much as 50 per cent of the growing chicks constitute cockerels which have to be reared along with the pullet chicks till they are separated from each other at the earliest recognition of their sexes. The sex of smaller or mediterranean breeds, like the Leghorns can be recognised when the chicks are about 4-5 weeks old, but that of the heavier breeds like the Rhode Island Reds cannot be distinguished till the birds are about 8 to 9 weeks old. As only a few selected chicks are required to be retained for breeding purposes, the majority of the cockerel chicks becomes surplus, the retention of which longer than it is absolutely essential is a drain on the feeds.

Cockerels do not fetch for their meat a price commensurate with the cost of feeding them. They also take up valuable room which can be used more economically for rearing pullets. The surplus cockerels should, therefore, be disposed of as early as practicable—at any rate not later than when they are 12 to 16 weeks old.

CAPON PRODUCTION

Capons are male birds whose testes are removed by what is called caponisation. While on the subject of disposal of surplus cockerels, it is necessary to deal with caponising, although capons do not at present offer any material advantage over uncaponised birds in this country.

Economics of Capon Production. Capons grow at about the same rate as cockerels, but growth in capons continues for a longer period than in cockerels. Up to about six months there is little difference in the weights of cockerels and capons, but after this period capons continue to lay on flesh and remain good for table use, while the cockerels show little increase in weight and the meat becomes tougher. In the Western countries there is an increasing demand for capons because of their superior meat quality. The flesh is of better flavour, much softer, and of finer texture. Capons fetch a somewhat higher price in other countries where their production is justified. This is not, however, the case in India where, for reasons already discussed, it is of advantage to dispose of the surplus cockerels as early as possible, at any rate not later than when 4 months old. At this age the capon

has no advantage over the cockerel as regards the body weight, although capons bear confinement well and do not fight or worry each other as cockerels do.

The right age for caponising cockerels is when they are between 10 to 12 weeks old. Only healthy and vigorous birds should be caponised. Heavier breeds like Rhode Island Red and Barred Plymouth Rock make more satisfactory capons than the lighter breeds like the Leghorns.

Surgical Caponisation. Surgical caponisation is a simple operation when once the technique is understood thoroughly and practised on a few birds. It can be tried by a beginner on those that are intended for the table or on the dead cockerels before operating on live birds.

The following instruments are necessary. They can either be got made locally or a standard 'caponising set' can be purchased from any firm dealing in poultry equipment or veterinary instruments (Fig. 146)

- (1) A remover which may either be a set of forceps or a scoop for removing the testes.
- (2) A pair of spreaders or retractors, to hold the wound open during the operation.
- (3) A sharp pointed hook to tear off the peritoneum—the thin membrane covering the intestines and other abdominal organs.
- (4) A pair of forceps for removing any foreign bodies such as feathers, etc., that may accidentally drop into the abdominal cavity.
- (5) A sharp pointed knife for opening the abdomen.
- (6) Twine of sufficient size and strength, to be used for restraining the birds. If there is an assistant at hand this is not necessary.

Birds to be caponised should not be fed for at least 24 hours before the operation. This is necessary as intestines filled with food will hinder free access to the testes. It is also advisable to withhold water, as an abundance of it increases the fluid in the body tissues and causes more haemorrhage.

The operation is best done outdoors where there is bright sunlight, preferably under the shade of a building or tree. The operation may be performed on an inverted barrel, a box of sufficient height, or a small table.

If there is no assistant to hold the bird, fasten both the wings and legs together with a piece of twine and secure them by means of weights hung over the edges of the barrel or table top.

The seat of operation is the space between the last two ribs (Fig. 142). This can be felt in front of the hip. Some feathers are plucked over this area to expose the skin and the feathers around it moistened so that they do not disturb the operator.

Disinfectants are not necessary, although it is a good practice to boil the instruments before the operation. After operating a few birds the instruments should be dipped in clean hot water to remove blood and dirt.

There are two ways of opening the abdominal cavity. These are described below:

- (1) The skin is pushed aside over the last intercostal space towards

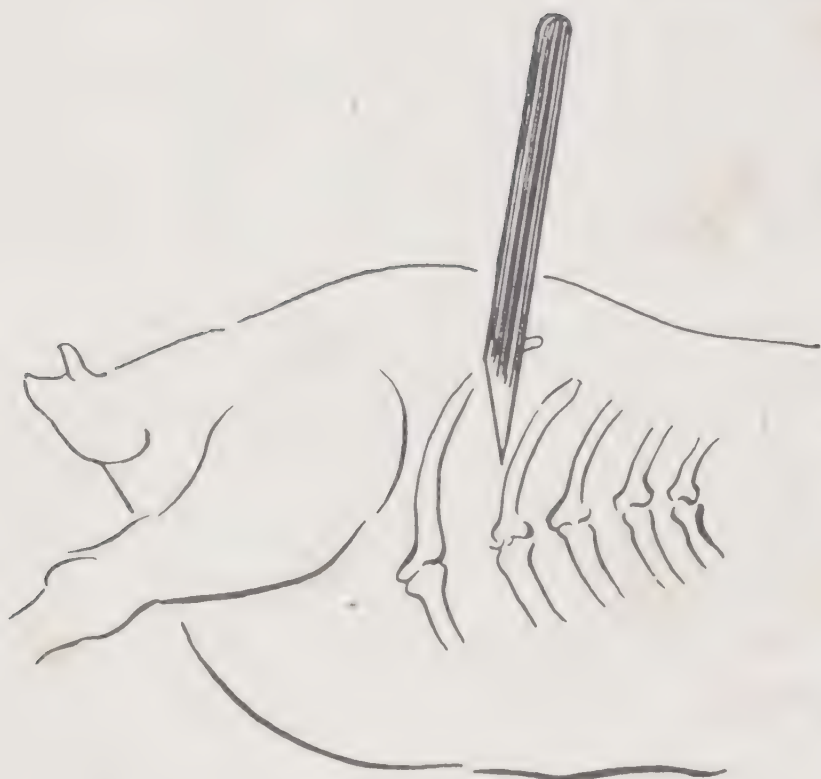


FIG. 142. FIRST STAGE OF CAPONISATION: CUTTING THROUGH THE SKIN AND MUSCLES BETWEEN THE LAST TWO RIBS

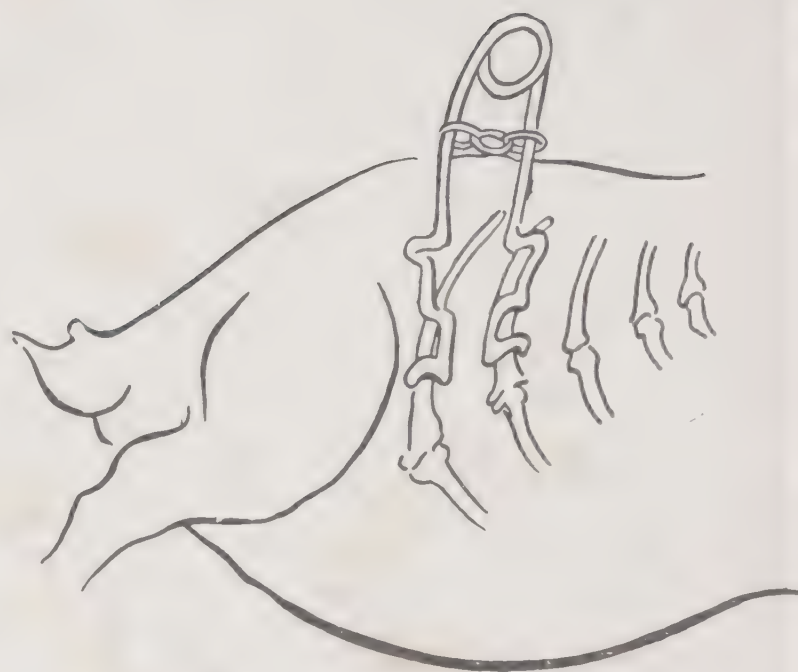


FIG. 143. SECOND STAGE: INSERTING THE SPREADER FOR SPREADING THE RIBS TO ADMIT THE FORCEPS



FIG. 144. THIRD STAGE: REMOVING THE TESTES (*From Bulletin No. 4 on Poultry Raising, Department of Agriculture, Manila*)



FIG. 145. GRADING OF EGGS

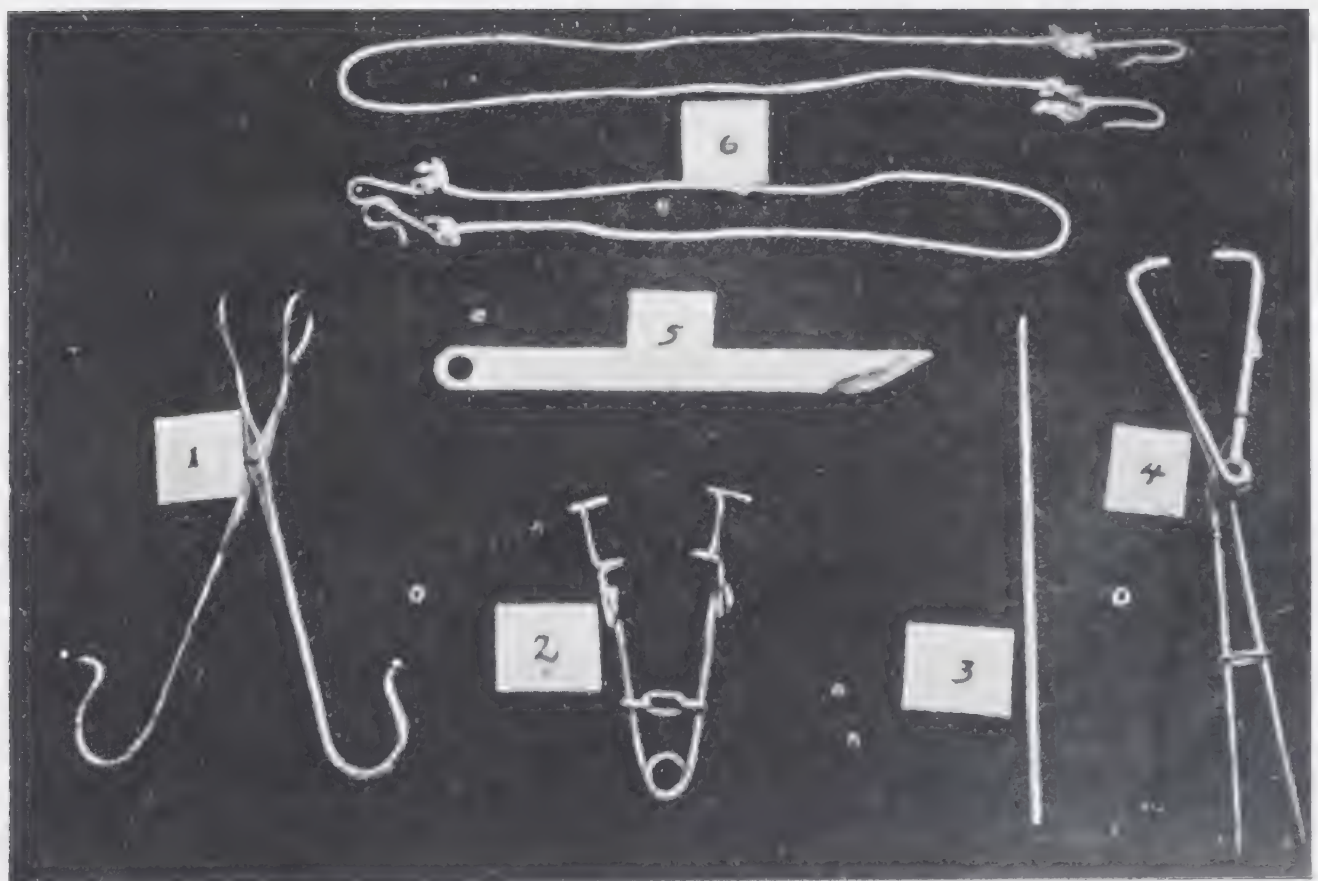


FIG. 146. CAPONISING INSTRUMENTS: (1) CAPONISING FORCEPS, (2) RETRACTORS, (3) SHARP POINTED HOOK AND PREBLE (COMBINED), (4) FORCEPS, (5) A SHARP POINTED KNIFE FOR OPENING ABDOMEN AND (6) TWINE WITH HOOKS FOR RESTRAINING BIRDS



FIG. 117. GOOD QUALITY BASKETS USED FOR PACKING EGGS

the left with the middle finger of the left hand. With the fore-finger of the same hand, the last two ribs which are nearest the hip are located. The skin is cut and the muscles between them incised to enter the abdominal cavity by drawing the sharp edge of the knife towards the sternum. The opening may be made of the desired size to suit the operator, but generally not exceeding an inch and a half in length.

- (2) The skin is pushed towards one side and then cut through over the region of the last two ribs. This exposes the oblique abdominal muscle covering the last rib, and when the muscle is pulled aside with the aid of either a retractor or the hook, the last intercostal space is brought into view. A second incision of the desired length is now made through the muscles of the last intercostal space, taking care not to injure the oblique abdominal muscles or the blood vessel lying close to the posterior border of the last but one rib.

The spreaders are now inserted (Fig. 143) to spread the ribs sufficiently far apart so as to admit the scoop or forceps. The peritoneum which is exposed is torn apart with the hook in case it has not already been torn by the incision of the abdominal and intercostal muscles. This brings into view the intestines which should be pushed towards one side with the aid of the probe in order to get the testes in sight.

The testes may be recognised by their bean-shaped form, generally yellowish in colour, and varying in size with the age of the cockerel. They can be removed easily by using either the scoop (Fig. 144) or the forceps, the former being safer. With the forceps the large blood vessels are liable to be injured resulting in death. If the scoop is used, the testes can be removed by applying the instrument to the spermatic cord. Then with a gentle lift accompanied by a twisting movement the testes can be severed from their attachments.

It is absolutely necessary to remove the whole testes, for if a portion of them is left, it will again grow partially resulting in the development of a 'slip' which is neither a capon nor a rooster. It is an undesirable bird being no better than a rooster.

The other testes can be removed from the same opening, but this requires considerable practice and experience. Novices or inexperienced operators will, therefore, do better to remove the testes from each side of the bird separately as it is a safer course to follow.

Suturing the operation wound is neither necessary nor recommended, because chickens are practically immune to septic infection, and also because the muscle wounds are automatically covered by the skin as soon as the bird is released from the operation table. Healing of the wound generally takes place uneventfully and the birds make a complete and satisfactory recovery within a few days.

The instruments should be cleaned after the operation and thoroughly dried before they are transferred back to their case.

After the operation the birds should be handled as gently as possible. They should be housed by themselves and not crowded in coops or compartments where they are liable to receive injuries. The operated birds should be observed closely for at least two hours after the operation, and those that show extreme weakness resulting from haemorrhage should be killed. They can be used for table, and also those that may happen to die during the operation. Only soft feed and plenty of water should be given to them for a few days. At the end of a week's time the capons can be released and gradually put on their regular ration.

Capons are preferred to ordinary birds, especially at Christmas time, in big cities with a large European and Christian population. Poultry farms in the vicinity of such urban areas would find it profitable to convert their surplus male stock into capons well in time to get them ready for table near the Christmas time.

Chemical Caponisation. Cockerels can also be emasculated by chemical methods without recourse to a surgical operation. This is done by implanting under the skin synthetic female hormones or oestrogens, such as *Stilboestrol dipropionate* in tablet form. The tablet is implanted under the skin as near as possible to the head either by means of a special syringe or by making a simple slit in the skin with a knife at the base of the head and introducing the tablet under it, the slit being either closed with a single stitch after the introduction of the tablet or left as it is. The cockerels so treated soon begin to lose their male characters as in the case of surgically caponised birds. As long as the effect of chemical caponisation lasts, which is determined by the persistence of the synthetic hormone introduced under the skin, the male sex characters continue to remain suppressed, but reappear as soon as the effect wears out. Generally, the effects persist for about 3 months during which the birds continue to put on weight and present all the characters of real capons. However, after this period there is very little gain in weight.

While using chemically caponised birds for table that portion of the chicken's body which has the implanted tablet of synthetic hormone should be carefully removed and discarded. This is because of the possible ill effects of such hormones on the consumers. This is why the tablet is required to be implanted as high on the base of the head as possible, so that it is easier to sever the head and discard it before cooking.

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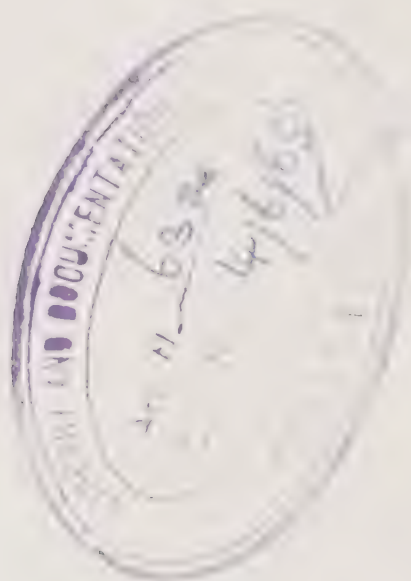
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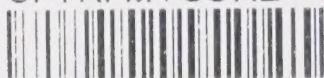
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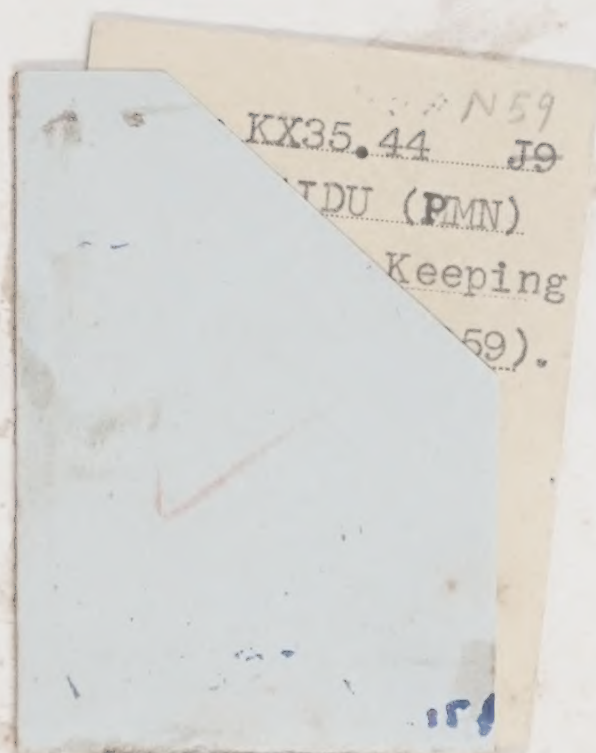


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